Test Preparation Study Guide
for
Coal Mine Certification

UNDERGROUND MINE FOREMAN

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For
Coal Miner Certification

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CHAPTER ONE

MINE GASES

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MINE GASES
GENERAL

1. Where is every operator required to employ a fire boss?

2. What are the qualifications for fire bosses employed in Utah coal mines?

3. Who, in case of necessity, is permitted to pass beyond a danger signal at the entrance of a mine?

4. What is the duty of a fire boss when he finds, what he considers, a danger to persons entering an area or place?

5. If the fire boss reports the results of his examination by phone or radio, who is qualified to receive and record the message?

6. Who is subordinate to the fire boss in the performance of his duties?

7. If a mine is found unsafe under what circumstances may a person or persons enter?

8. Who shall examine persons in the use of approved methane detectors?

9. How often must the mine foreman or his assistants visit and check all working places for methane and oxygen deficiency?

10. What must be done if the methane content is found in excess of one percent in any active working place?

11. What evidence is required that working places have been examined?

12. Who shall be superior to the fire boss in the performance of his duties?

13. What shall be done at or near working faces before and during, welding or cutting in all mines?

14. Where electric equipment is operated in all coal mines, how often must examination for gas be made?

15. What articles of every day use are prohibited in all coal mines?

16. What is required before any electric equipment is permitted to pass beyond the last breakthrough in all mines?

17. When is it unlawful for a person to enter a coal mine?

18. What shall be done in all mines, or sections thereof, before each shift commences work?

19. Who shall prepare the danger signal at the mine entrance?

20. When may the danger signal at the entrance of a mine be removed?

SAMPLE QUESTIONS FOR MINE LAW

1. What provisions shall the operator make to ensure that any person entering the underground area of the mine does not carry smoking materials, matches, or lighters?
    a. The operator shall institute a program approved by the Secretary
    b. The operator shall institute a program approved by the Mine Superintendent
    c. The operator shall adopt a policy which shall be approved by the top company management
    d. None of the above

2. All persons who perform the work of removing permanent roof supports shall be supervised by a management person experienced in removing roof supports and with at least _____ of underground mining experience shall perform permanent roof support removal work.
    a. Four years
    b. Three years
    c. Two years
    d. One year
    e. None of the above

3. How often must escapeways be examined?
    a. At intervals not exceeding seven days
    b. Every thirty working days
    c. Once a year
    d. Every ninety days
    e. None of the above

4. The certified person scheduled to conduct a scheduled pre-shift examination of a working section calls in sick at the last minute. At the beginning of the established 8 hour interval, what must the miners working in that section do?
    a. Keep working until they are informed that an unsafe condition exists
    b. Move out of that section until the pre-shift examination is properly conducted
    c. Go immediately to the surface via the nearest escapeway
    d. Perform the required pre-shift examination themselves

5. When is it permissible to transport liquefied and non-liquefied compressed gas cylinders on mantrips?
    a. If they are transported in a special compartment designed for that purpose
    b. Never, except in emergencies
    c. It's OK if the gas cylinders are mounted securely
    d. Under no circumstances shall compressed gas bottles be transported on mantrips.
    e. Only if the gas cylinders are mounted in a non-conductive material

6. In what quantity shall rock dust be maintained on the roof, ribs and bottom of the intake, beltline, or working section?
    a. Rock dust shall be maintained in such quantity that the incombustible content of the mine dust shall not be less than 65%
    b. Rock dust shall be maintained in such quantity that the incombustible content of the mine dust shall not be less than 75%
    c. Rock dust shall be maintained in such quantity that the incombustible content of the mine dust shall not be less than 85%
    d. Rock dust shall be maintained in such quantity that the incombustible content of the mine dust shall not be less than 90%

7. Each coal mine shall be provided with suitable fire fighting equipment adapted for the size and condition of the mine. Who shall establish minimum requirements of the type, quality, and quantity of such equipment?
    a. The mine superintendent
    b. The safety manager
    c. The Secretary of Labor or delegate
    d. The mine maintenance superintendent
    e. None of the above

8. How many open roadways are permitted leading to the mining of a final stump or push-out?
    a. Only one open roadway is permitted
    b. Only two open roadways are permitted
    c. There are no restriction on roadways
    d. Push-out stumps are designed to crush out if the pillar extraction plan is properly designed and followed

9. Which of the following is not a requirement for the transportation of compressed gas cylinders?
    a. They must be equipped with a metal cap to protect the cylinder valve during transit
    b. They must be labeled “empty” or “MT” when the gas in the cylinder has been expended
    c. Cylinders shall be placed in well insulated and substantially constructed containers which are specifically designed for holding such cylinders prior to transportation
    d. Placed securely in devices designed to hold the cylinder in place during transiton self propelled equipment or belt conveyors
    e. Shall be handled only by the person(s) performing the welding or soldering task

10. Pillar recovery mandates that only one open roadway, which shall not exceed _____ feet wide, shall lead from solid pillars to the final stump or a pillar. Where posts are used as the sole means of roof support, width of the roadway shall not exceed _____.
    a. 12 feet and 10 feet
    b. 16 feet and 14 feet
    c. 18 feet and 16 feet
    d. 20 feet and 18 feet
    e. None of the above

Air Quality In Perspective

AIR IS DEFINED as an invisible, odorless and tasteless mixture of gases, which consist chiefly of nitrogen and oxygen, together with minor amounts of argon, carbon dioxide, water vapor and minute quantities of helium, krypton, neon and xenon.

As a practical matter, however, air from the earth's very beginning has also contained dust, sand, smoke, ash and numerous other ingredients neither invisible, odorless nor tasteless. The cataclysmic upheavals and eruptions of molten matter that gave rise to the earth more or less as we know it today were accompanied by one of the most dramatic examples of air pollution ever experienced on this planet.

The advent of plant life and, later, animal life has contributed significantly to the amount of extraneous matter present in the earth's air. Vegetation constantly emits spores, mold and pollen into the earth's atmosphere. The decomposition of dead plant and animal life further affects the quality of the air. Smoke, so often regarded as a result of industrial development, has also been a component of earth's air since the evolution of vegetation, when forest and plain fires ignited by lightning raged uncontrolled across the face of the earth. Volcanic eruption directly contributed immeasurable amounts of particulate and gaseous matter to the atmosphere and was another prime source of forest fires.

Finally, dust, that venerable scourge of the housewife, has been a fixture of this planet since the beginning of time.

It is interesting to note that dust also has its beneficial aspects since it is the scattering of sunlight by dust particles suspended in the air that created beautiful sunsets.

So, significant is the contribution of dust to our atmosphere that Louis V. Olson, former Director of Asarco's Department of Agricultural Research, has said "…a single dust storm in the Southwest, in North Africa, or in the Near East may carry more solid materials into the air than the sum-total of all that from our present factories, power plants, mills, smelters and household heating devices over a period of many months." For decades, astronomers have been observing the spectacle of profound dust storms upon the surface of Mars while the question of whether Saturn's rings are also produced by dust upon that planet is today being debated by astronomical academicians.

Despite such numerous indications that absolutely "pure" air has probably never existed since the birth of this planet, the interest in air quality today far surpasses that of any other time with advocates of so-called "clean" air becoming increasingly vocal.

The World Health Organization of the United Nations, for example, has estimated that the total number of technical papers published since World War II on the subject of atmospheric pollution has more than equaled the number of papers published in all of the time prior to the War.

PROPERTIES OF MINE GASES

NAME OF GAS	CHEMICAL SYMBOL	SPECIFIC GRAVITY	COM-BUSTIBLE	LBS. PER CU. FT. AT 600f AND 30.00 IN. OF MERCURY	EFFECT ON LIFE	SOURCE OR CAUSE WHERE FOUND	EXPLOSIVE RANGE PERCENT BY VOLUME	COMMON NAME	LOWEST IGNITION TEMPS.	HOW DETECTED	COLOR-LESS	ODOR-LESS	TASTE-LESS
Air		1.000	Supports	.0765	Sup-ports	Atmosphere	None						
Oxygen	O2	1.105	Supports	.0846	Sup-ports	1.5 of atmosphere	None			Flame safety lamp O2 detector	X	X	X
Methane	CH4	.555	Yes	.0424	Inert	Coal carbonaceous shale	5.0% - 15.0%	Marsh gas, fire damp	1200OF	Methanometer	X	X	X
Carbon Dioxide	CO2	1.529	No	.1170	Poisonous in high concentration	Oxid of coal blasting, mine fires, decay, acid waters, breathing	None	Black damp		Colorimetric analysis	X	X	X
Carbon Monoxide	CO	.967	Yes	0.0740	Poisonous	Incomplete combustion, mine fires, explosions, blasting	12.5% - 74.0%	White damp	1190OF	CO detector, canary	X	X	X
Nitrogen	N2	.967	No	.0740	Inert	About 4/5 of atmosphere	None			Analysis	X	X	X
Hydrogen Sulfide	H2S	1.191	Yes	.0911	Poisonous	Explosions, mine fires, blasting	4.3% - 46.0%		655OF	Hydrogen sulfide detector acetate of lead	X	Sulfur odor	X
Nitrogen Peroxide	NO2	1.589	No	.1217	Poisonous	By burning of high explosives	None			Starch & potassium iodide	Turns blue with trace	Odor of burning explosives	X
Nitrogen Dioxide	NO2	1.503	No		Poisonous	Blasting, burning ex-plosives, burning nitrates	None			Analysis	Brownish red		
Sulfur Dioxide	SO2	2.263	No	.1733	Poisonous	By burning pyrites or other	None			Odor, colorimetric analysis	X	Sulfur Odor	Acidic taste
Hydrogen	H2	.070	Yes	.0053	Inert	Charging batteries, mine fires, explosions	4.1% - 74.0%		935OF	Analysis	X	X	X
Acetylene	C2H2	.907	Yes	.0694	Slightly poisonous	Chemical action of water on cal. Car-bide lamps	2.5% - 80.0%		636OF	Odor	X	Garlic odor	X

PROPERTIES OF GASES

The weights and volumes of gases change with temperatures and barometric pressure. For purposes of comparison the weights have been calculated at a temperature of 60^{o} F., and a pressure of 30.00 inches of mercury, the approximate barometric pressure at sea level.

The specific gravity of a gas is generally considered as the ratio between the weight of a unit volume of the gas and the weight of the same column of air at the same temperature and pressure. In order to calculate this ratio, the specific gravity of air is arbitrarily taken as one (1). If a gas is heavier than air, its specific gravity is greater than one, (1) and if it is lighter than air, its specific gravity is less than one (1).

OXYGEN DEFICIENCY

OXYGEN PRESENT	EFFECT
21%	Breathing easiest
17%	Breathing faster and deeper
15%-	Dizziness, buzzing noise, rapid pulse, headache, blurred vision
9%	May faint or become unconscious
6%	Movement convulsive, breathing stops, shortly after heart stops

PHYSIOLOGICAL EFFECTS OF CARBON MONOXIDE

Concentration of CO, Percent	**Allowable Length of Exposure**
0.01	Allowable for exposure of several hours
0.04 to 0.05	Can be inhaled for 1 hour without appreciable effect
0.06 to 0.07	Just noticeable effects after 1 hour exposure
0.10 to 0.12	Unpleasant, but probably not dangerous after 1 hour exposure
0.15 to 0.20	Dangerous for exposure of 1 hour
0.4 or more	Death in less than 1 hour

AIR

21. What is air?

22. What are the constituents of pure dry air?

23. What is the specific gravity of air?

24. What is the weight of one (1) cubic foot of air at 60^{o} F. and thirty (30) inches of mercury pressure?

25. What is the essential function of air?

26. Where are dangerous or injurious atmospheres most likely to be found in mines?

27. What precaution should be observed before a workman is sent into an abandoned or idle place?

28. What is a respirable atmosphere?

29. What is an irrespirable atmosphere?

30. What is meant by the term "Humidity"?

31. What effect does temperature have upon the amount of moisture, which can be absorbed by air?

32. What is the effect of high temperature and high humidity upon workers?

33. What effect does a low outside temperature (below 60^{o} F) have upon the humidity of a mine?

34. What effect does a high outside temperature (above 60^{o} F) have upon the humidity of a mine?

35. What changes occur in air used to ventilate a mine?

36. What effect does a change in temperature have upon the volume of a gas?

37. What is meant by absolute temperature?

38. What is the absolute temperature if the thermometer reading is 60^{o} F?

39. If the volume of air measures one hundred (100) cubic feet at 32^{o} F, what would be the volume if the temperature was increased to 60^{o} F., pressure remaining the same?

40. If the temperature of a volume of gas remains the same, what effect does increasing the pressure have upon the volume of gas?

41. If the volume of air measures one hundred (100) cubic feet when the barometer is 29.00 inches, what would be the volume if the barometer fell to 28.00, temperature remaining the same?

42. What is the pressure per square inch when the barometer is 28.5 inches?

43. What effect does a change in both temperature and pressure have upon the volume of a gas?

44. If the volume of air measures one hundred (100) cubic feet at 32^{o} F and 15 pounds pressure (30.54 inches barometer), what would be the volume at 80^{o} F and 14 pounds pressure (28.51 inches barometer)?

45. What is meant by the diffusion of gases?

46. How does the diffusion rate of gases vary?

47. Will diffused gases separate from a mixture because of their differences in weight?

48. Which is the easier to remove, a body of methane or carbon dioxide?

METHANE

50. What is methane (CH_4)?

51. What is the source of methane in coal mines?

52. Where is methane found?

53. What is the composition of methane?

54. What is the specific gravity of methane?

55. What is the weight of one cubic foot of methane at 60^{o} F and 30.00 inches of mercury pressure?

56. Where is methane usually found in mines?

57. Why is methane not explosible by itself?

58. What is firedamp?

59. What is the range of explosibility for methane?

60. Why can there be no explosion when the percentage of methane is less than five percent (5%)?

61. Why can there be no explosion when the percentage of methane is greater than fifteen percent (15%)?

62. What is the percentage of methane required for maximum explosive violence?

63. What is the percentage of oxygen below which no explosion of a methane air-mixture can occur?

64. What effect does an atmosphere with a reduced oxygen content have upon the explosibility of methane?

65. What effect does the presence of methane have upon the explosibility of coal dust?

66. What effect does coal dust in the air have upon the explosibility of methane?

67. How can methane be detected?

68. What dangerous gas is most likely to be encountered above a pillar fall?

69. If a split of air of twenty thousand (20,000) cubic feet per minute contains three percent (3%) methane, how many cubic feet per minute would be required to reduce the methane content to one percent (1%)? **Note:** Change all percentages to decimals (1% = .01 3% = .03).

70. If a split has 30,000 cubic feet of air per minute and the methane content is 0.5%, how many cubic feet of methane is liberated per minute?

71. If a section of a mine liberates 350 cubic feet of methane per minute, how many cubic feet of air is required to reduce the percentage of methane in the return to seventy-five hundredths percent (.75%)? **Note:** 0.75% = .0075

OXYGEN

72. What element in air is essential for life?

73. What is oxygen (O_2)?

74. How does the body receive oxygen?

75. What chemical change does oxygen undergo in the support of life?

76. What effect does a deficiency in the normal content of oxygen in air have upon life?

77. What is blackdamp?

78. What is the specific gravity of oxygen?

79. What changes occur to oxygen, in an atmosphere confined in the presence of coal?

CARBON DIOXIDE

80. What is carbon dioxide (CO_2)?

81. How is carbon dioxide formed in a mine?

82. What is a product of complete combustion?

83. What is the specific gravity of carbon dioxide?

84. What is the weight of one (1) cubic foot of carbon dioxide at 60^o F and 30.00 inches of mercury pressure?

85. Is carbon dioxide combustible?

86. Where might concentrated accumulations of carbon dioxide ordinarily be found?

87. What effect does carbon dioxide have upon life?

88. How is carbon dioxide detected?

CARBON MONOXIDE

89. What is carbon monoxide (CO)?

90. How can carbon monoxide be detected?

91. What is the source of carbon monoxide?

92. When is carbon monoxide most likely to be found in mines?

93. What is afterdamp?

94. What kind of engines produce carbon monoxide?

95. What is the principal poisonous gas produced by explosives?

96. What effect does carbon monoxide have on life?

97. How does carbon monoxide cause injury to life?

98. What percentage of carbon monoxide will produce symptoms in several hours?

99. What percentage of carbon monoxide will produce discomfort in two or three hours?

100. What percentage of carbon monoxide will produce a tendency to stagger in one and one-half (1 1/2) hours?

101. What percentage of carbon monoxide will produce symptoms of unconsciousness in thirty (30) minutes?

102. How much greater affinity does hemoglobin have for carbon monoxide than for oxygen?

103. Why are small quantities of carbon monoxide injurious?

104. What is the specific gravity of carbon monoxide?

105. What is the weight of one (1) cubic foot of carbon monoxide at 60^{o} F and 30.00 inches of mercury pressure?

106. What is the colorimetric carbon monoxide tester?

107. What is the range of the colorimetric carbon monoxide tester?

108. What is the Monoxor carbon monoxide indicator?

109. What is the range of the Monoxor carbon monoxide indicator?

110. What is the Monoxor carbon monoxide detector?

SULPHUR DIOXIDE

111. What is sulphur dioxide (SO_2)?

112. How is sulphur dioxide formed in a mine?

113. What is the specific gravity of sulphur dioxide?

114. What is the weight of a cubic foot of sulphur dioxide at 60^{o} F and 30.00 inches of mercury pressure?

115. What is the particular danger of sulphur dioxide?

116. What percentage of sulphur dioxide will result fatally?

117. How is sulphur dioxide detected?

118. What is the first effect on a person exposed to sulphur dioxide?

119. Is sulphur dioxide combustible?

HYDROGEN SULPHIDE

120. What is hydrogen sulphide (H_2S)?

121. What mine gas can be detected by its odor?

122. What is the origin of hydrogen sulphide?

123. How can hydrogen sulphide be detected other than by sense of smell?

124. What is the specific gravity of hydrogen sulphide?

125. What is the weight of one (1) cubic foot of hydrogen sulphide at 60^o F and 30.00 inches of mercury pressure?

126. What is the range of explosibility of hydrogen sulphide?

127. Is hydrogen sulphide poisonous?

128. What is the most violent explosive point of hydrogen sulphide?

129. What is the temperature of ignition of hydrogen sulphide?

130. What percentage of hydrogen sulphide will result fatally if breathed for some time?

131. What is the immediate effect of hydrogen sulphide on a person?

NITROGEN

132. What is nitrogen (N_2) ?

133. Is nitrogen combustible?

134. What effect does nitrogen have towards propagating an explosion?

135. What is the specific gravity of nitrogen?

136. What is the weight of a cubic foot of nitrogen at 60^o F and 30.00 inches of mercury pressure?

137. What effect does nitrogen have upon life?

NITROGEN DIOXIDE

138. What is Nitrogen Dioxide (NO_2)?

139. What is the specific gravity of Nitrogen Dioxide?

140. What is the weight of a cubic foot of Nitrogen Dioxide at 60^o F and 30.00 inches of mercury pressure?

141. Is Nitrogen Dioxide combustible?

142. What percentage of Nitrogen Dioxide will be fatal?

143. How may traces of Nitrogen Dioxide be detected?

144. What are the first effects of Nitrogen Dioxide on a person?

145. What is the particular danger of Nitrogen Dioxide?

HYDROGEN

146. What is hydrogen (H_2)?

147. How is hydrogen formed in a mine?

148. Is hydrogen explosive?

149. What is the specific gravity of hydrogen?

150. What is the weight of a cubic foot of hydrogen at 60^o F and 30.00 inches of mercury pressure?

151. What is the explosive range of hydrogen?

152. What is the ignition temperature of hydrogen?

153. How is hydrogen detected?

SAMPLE QUESTIONS FOR
MINE GASES

1. What is the particular danger of sulfur dioxide?
    a. It is extremely combustible
    b. It is extremely poisonous
    c. It causes oxygen deficiency
    d. It may cause coal dust explosions

2. Which of the following gases is the most dangerous underground in terms of an explosion?
    a. Carbon dioxide
    b. Nitrogen
    c. Methane
    d. Oxygen

3. Pure dry air contains about _____.
    a. Oxygen-16.25%, nitrogen-81.75%, carbon monoxide-2%
    b. Oxygen-22.9%, nitrogen 74.1%, carbon monoxide-3%
    c. Oxygen-21%, nitrogen-79%, carbon dioxide-0.03%
    d. Oxygen-22%, nitrogen-76%, carbon monoxide-1%
    e. None of the above

4. What other gas must be present before methane can explode?
    a. Oxygen
    b. Nitrogen
    c. Carbon dioxide
    d. None of the above

5. How is hydrogen sulfide detected?
    a. By the Bacharach electronic canary
    b. By its odor and by hydrogen sulfide detectors
    c. By its color and by hydrogen sulfide detectors
    d. None of the above

6. What is the explosive range of hydrogen?
    a. 4.1% to 7.4%
    b. 41% to 74%
    c. 4.1% to 74%
    d. 7.4% to 41%
    e. Hydrogen is flammable, but not explosive

7. If hydrogen is present with an explosive mixture of methane gas, the atmosphere is _____.
    a. Not explosive
    b. More dangerous than methane by itself
    c. Difficult for breathing
    d. Absorbed by the coal and the surrounding strata
    e. None of the above

8. If an air spit has 20,000 cfm with 4% CH_4 being liberated, how many cfm will be required to reduce the CH_4 content to 1%?
    a. 60,000 cfm
    b. 80,000 cfm
    c. 100,000 cfm
    d. 120,000 cfm
    e. None of the above

9. Is hydrogen sulfide poisonous?
    a. No
    b. Yes, it is extremely poisonous
    c. Yes, but only when present in large amounts
    d. Only when present with oxygen

10. How many parts per million (ppm) of carbon monoxide in the air can be fatal in 3 hours?
    a. 50 ppm
    b. 100 ppm
    c. 500 ppm
    d. 800 ppm
    e. None of the above

ANSWER SHEET FOR GENERAL

1. In all coal mines
2. He shall hold a certificate of competency for such position issued to him by the Utah Labor Commission. He must be a citizen, resident or employed in a mine in the state at the time of his examination. He must have at least two years experience in underground working.
3. No person except the mine owner, operator or agent.
4. He shall place a conspicuous danger sign at all entrances to such place or places.
5. A certified person designated by mine management.
6. All employees working inside of such mine or mines.
7. Under the direction of the fire boss or bosses and then for the purpose of assisting in making the mine safe.
8. A qualified official from the MSHA.
9. At least once every twenty minutes during each coal-producing shift, or more often if necessary.
10. All equipment shall be de-energized and disconnected from the power supply until determined to be safe to restore power.
11. The date of examination and initials should be marked at the face.
12. He shall have no superior officer.
13. Certified person shall examine for gas with approved detectors.
14. Not to exceed twenty minutes.
15. Smoking materials and unapproved devices for making lights.
16. The place must first be examined for gas and found to be safe.
17. Before it is reported safe, except for those persons already on assigned duty.
18. Fire boss examinations shall be made.
19. The fire boss or a certified person acting as fire boss.
20. When the mine, or parts, thereof, are reported safe by the fire boss.

ANSWER SHEET FOR MINE LAW

1.	a	6.	a
2.	d	7	c
3.	a	8	a
4.	b	9	e
5.	d	10.	b

ANSWER SHEET FOR AIR

21. The mixture of gases surrounding the earth, forming the atmosphere.
22. Oxygen (O_2), 20.93%, Nitrogen (N_2), 78.10%, Carbon Dioxide (CO_2), 0.03%, and other rare gases .94%
23. For the purpose of comparing the weight of other gases to the weight of air, the specific gravity of air is taken as one (1.00).
24. 0.0765 pound per cubic foot.
25. To support life and combustion.
26. In unventilated abandoned areas or idle working places.
27. The foreman should first have the place tested for ventilation, gases, and roof conditions.
28. One suitable to sustain life.
29. One unsuitable for sustaining life.
30. The degree to which air is saturated with moisture.
31. As the temperature of air increases, the capacity to absorb moisture increases.
32. It makes it increasingly difficult to accomplish work.
33. Usually the temperature is low enough that one hundred percent (100%) saturation is not uncomfortable.
34. As the temperature of the intake air increases, the moisture enters the air, thus drying out the mine.
35. As the intake air cools, the ability to retain moisture decreases, moisture is deposited in the mine, and humidity is increased.
36. It may mix with methane, carbon dioxide or other gas, lose oxygen by absorption or combustion, and either absorb or deposit moisture.
37. The pressure remaining the same, the volume of a gas changes directly in proportion to its absolute temperature.
38. At 32^o F a gas changes 1/491.64 part of its volume for each 1^o F change in temperature, therefore , theoretically it would disappear if the temperature fell 491.64^o or to -459.64^o (absolute zero). The absolute temperature of a gas is the number of degrees F it is above -460^o F.
39. $460^o + 60^o = 520^o$
40. 105.69 cubic feet

    Solution: $V = 100$, $T = 460 + 32 = 492$

    $t = 460 + 60 = 520$

    $v = \frac{100 \times 520}{492} = 105.69$ cubic feet
41. The temperature remaining the same, the volume of a gas changes in inverse proportions to its absolute pressure.
42. 103.57 cubic feet.

    Solution: $V = 100$, $P = 29.00 \times .491 = 14.24$ lb.

    $p = 28.00 \times .491 = 13.75$ lb

    $v = \frac{100 \times 14.24}{13.75} = 103.57$ cubic feet
43. Since each inch of mercury is equivalent to a pressure of .491 pounds per square inch, 28.5 inches would be 28.5 x .491 or 13.99.
44. The change in volume is directly proportional to the change in absolute temperature

and inversely proportional to the change in absolute pressure.

45. 117.60 cubic feet.
    Solution: V = 100 , T = 460 + 32 = 492 , P = 15
    t = 460 + 80 = 540 , p = 14
    $v = \frac{100 \times 540 \times 15}{492 \times 14} = \frac{810.000}{6.888} = 117.60$ cubic feet
46. Their mixing with each other when they contact.
47. Their rates of diffusion vary in inverse proportion to the square roots of their densities. Light gases diffuse move readily than heavy gases.
48. No. They will not separate or stratify once they have been diffused or mixed.

ANSWER SHEET FOR METHANE

50. A colorless, odorless and tasteless combustible gas.
51. It is liberated from coal and adjoining strata.
52. In almost all coal mines
53. Carbon and Hydrogen (CH_4), one part carbon and four parts hydrogen.
54. 0.555
55. 0.0424 pound.
56. Along the roof, to the rises, in the vicinity of working faces, in dead ends and above falls.
57. Oxygen is required to support combustion.
58. An explosive mixture of methane and air.
59. Between five percent (5%) and fifteen percent (15%).
60. Because the heat, liberated by combustion, is dissipated into surrounding air sufficiently rapid to prevent flame propagation.
61. Because the amount of oxygen present is insufficient for rapid combustion to occur.
62. Ten percent (10%).
63. 12%
64. A greater percentage of methane is necessary to start an explosion in an atmosphere which contains less than the normal percentage of oxygen.
65. The coal dust is more easily ignited and the force of the explosion is greater.
66. The lower explosive limit is decreased.
67. By the use of methane detectors and by analysis.
68. Methane
69. Sixty thousand (60,000) cubic feet.
    Solution: $\frac{20{,}000 \times .03}{.01} = 60{,}000$ cubic feet
70. 150 cubic feet.
    Solution: 30,000 x .005 = 150 cubic feet
71. 46.317 cubic feet
    Solution: $\frac{350}{.0075} = 46{,}667$, 46,667 - 350 = 46,317 cubic feet

ANSWER SHEET FOR
OXYGEN

72. Oxygen
73. It is a tasteless, odorless, and colorless gas which supports life and combustion.
74. Through breathing air, the oxygen is taken up by the hemoglobin of the blood and carried to all parts of the body.
75. The oxygen combines with the carbon contained by waste products in the body and forms carbon dioxide (CO_2).
76. Breathing becomes faster and deeper as the deficiency increases. Atmospheres with less than sixteen (16) percent oxygen are dangerous, and persons entering such atmospheres should carry protection.
77. An atmosphere deficient in oxygen.
78. 1.105
79. 0.0846 pound.

ANSWER SHEET FOR
CARBON DIOXIDE

80. Carbon Dioxide is a colorless and odorless gas formed by the chemical combination of carbon and oxygen.
81. By combustion, by breathing of men and animals, by decay of vegetable and animal matter, by the oxidation of coal and by chemical action of acid water on carbonates.
82. Carbon Dioxide.
83. 1.529.
84. 0.1770 pound
85. No, it is incombustible.
86. Near the floor, in dip workings, or in poorly ventilated places.
87. Lung ventilation is increases as carbon dioxide increases. When 5% of carbon dioxide is present lung ventilation has increased 300% and breathing is laborious and continued exposure is injurious.
88. Usually by chemical analysis.

ANSWER SHEET FOR
CARBON MONOXIDE

89. It is a colorless, odorless, tasteless, combustible and poisonous gas.
90. By carbon monoxide detectors, and by analysis.
91. It is the product of incomplete combustion (combustion with an insufficiency of oxygen).
92. When there is a mine fire or after an explosion.
93. The atmosphere following an explosion containing carbon dioxide, carbon monoxide, decreased oxygen, nitrogen, hydrogen and smoke.
94. Internal combustion engines.
95. Carbon monoxide.
96. It is extremely poisonous.
97. By combining with the hemoglobin of the blood and excluding oxygen.
98. Two hundredths of one percent (.02%).
99. Four hundredths of one percent (.04%).
100. Eight to twelve hundredths of one percent (0.08% - 0.12%).
101. Twenty to thirty hundredths percent (.20% - .30%)
102. About three hundred (300) times.
103. Because it is not easily thrown off and accumulates in the blood.
104. 0.967.
105. 0.0740 pound
106. An instrument for detecting carbon monoxide by the change in color of the chemicals inside a glass tube.
107. From 0.0001 to 0.10 percent by volume.
108. A carbon monoxide testing instrument from which it is possible to read the actual percentage of carbon monoxide by the length of a brown stain inside a glass indicating tube.
109. Form 0.001 to 0.2 percent by volume.
110. An instrument for detecting the presence of carbon monoxide by a brown stain in an indicator tube. It does not give an actual reading of the percentage of carbon monoxide.

ANSWER SHEET FOR
SULPHUR DIOXIDE

111. A colorless, suffocating, irritating, poisonous gas.
112. By burning coal containing pyrites or by the firing of black powder.
113. 2.263.
114. 0.1733 pound.
115. It is extremely poisonous even in small amounts.
116. Five hundredths of one percent (.05%).
117. By the sense of smell and its effect on the air passages.
118. It is extremely irritating and suffocating and is intolerable to breathe.
119. No, it is incombustible.

ANSWER SHEET FOR
HYDROGEN SULPHIDE

120. It is a poisonous, combustible, colorless gas having a sweetish taste and an odor like rotten eggs.
121. Hydrogen sulphide.
122. It is usually the product of the decomposition of sulphur compounds.
    NOTE: Burning of black powder. Action of acid water on metallic sulphides. Heating of sulphides in presence of moisture.
123. By the hydrogen sulphide detector or by paper dipped in acetate of lead, which will turn black immediately on exposure to hydrogen sulphide.
124. 1.191.
125. 0.0911 pound
126. Four and three-tenths percent (4.3%) to forty-six percent (46%).
127. Yes, it is extremely poisonous even in small amounts.
128. Fourteen percent (14%).
129. 655^{o} F.
130. Five hundredths of one percent (0.05%).
131. It is extremely irritating to the nostrils and eyes.

ANSWER SHEET FOR
NITROGEN

132. It is a tasteless, odorless and colorless gas, which will neither support life nor combustion.
133. No, it is incombustible.
134. None.
135. .967
136. 0.0740 pound.
137. It has no effect, except when it replaces oxygen to the extent that there is a deficiency of oxygen.

ANSWER SHEET FOR
NITROGEN DIOXIDE

138. It is an extremely poisonous gas frequently formed by the burning of high explosives.
139. 1.589.
140. 0.1217 pound.
141. No, it is incombustible.
142. Extremely low concentrations, probably about one hundredths of one percent (0.01%).
143. A paper soaked in a solution of starch and potassium iodide will turn blue when exposed to Nitrogen Dioxide.
144. It is extremely irritating to the nostrils and eyes.
145. Relatively small quantities may cause death even after apparent recovery.

ANSWER SHEET FOR HYDROGEN

146. It is a colorless, odorless, and tasteless gas.
147. It is formed by mine fires, explosions and by charging batteries.
148. Yes, it is explosive over a wide range.
149. It is the lightest of all gases. Specific gravity 0.07.
150. 0.0053 pound.
151. Form four and one-tenth percent (4.1%) to seventy-four percent (74%).
152. 935^{o} F.
153. By chemical analysis.

ANSWER SHEET FOR MINE GASES

1. b
2. c
3. c
4. a
5. b
6. c
7. b
8. b
9. b
10. d

CHAPTER TWO

VENTILATION

1. General
2. Stoppings
3. Line Brattice and Auxiliary Fans
4. Overcasts
5. Regulators
6. Doors
7. Check Curtains
8. Fans
9. Ventilation

VENTILATION
General

1. What is the purpose of mine ventilation?

2. How many openings are necessary to provide adequate ventilation?

3. What is the maximum distance permitted between slope and drift openings (intake and return)?

4. What is the minimum distance permitted between shaft and slope openings (intake and return)?

5. What is the minimum distance permitted between shaft openings (intake and return)?

6. What maximum number of persons may be employed in a mine before ample ventilation is required?

7. How shall mine ventilation be obtained?

8. What is the maximum distance that mines may be developed underground before mechanically operated fans are required?

9. When shall a mine be ventilated?

10. Why should a mine be ventilated continuously?

11. What must be the minimum oxygen content of air delivered to working places?

12. What is the maximum carbon dioxide content allowed in air delivered to working places?

13. What percentage of noxious or poisonous gases can be tolerated?

14. What must be the minimum amount of air passing the last breakthrough between intake and return in any set of entries?

15. What quantity of air must be delivered to the intake of a pillar line?

16. How is a mine ventilated?

17. In development work when the projected breakthrough distance exceeds 80 feet, what quantity of air is required at the last open breakthrough?

18. What are the main requirements of an intake opening?

19. What are the main requirements of airways?

20. What is a common fault of the two entry system?

21. How is the ventilating current controlled?

22. Through what portions of a mine must the air current not be permitted to pass before reaching working places?

23. What means must be used to insure ventilation at faces when projected breakthroughs are driven in excess of eighty (80) feet apart?

24. What means shall be used to insure ventilation at faces where unusual quantities of gas or smoke may exist.

25. Why should idle dead-end places not be permitted?

26. Where is it prohibited to turn rooms?

27. How should pillar lines be ventilated?

28. When men are discovered working in places in advance of air currents, what action should be taken?

29. What is the maximum distance that straight places may be driven beyond the last open breakthrough?

30. What is the minimum amount of air required passing the last open breakthrough if the breakthrough distance exceeds eighty (80) feet?

31. How often must the air currents be measured?

32. Where shall the air be measured?

33. What attention shall be given to the ventilating apparatus, airways and travelways of a mine foreman?

34. What action shall be taken in case of accident to the ventilation fan?

35. What action shall be taken before men are permitted to return after an accident to the ventilating fan?

36. Who is authorized to examine a mine after an accident to the ventilating fan?

37. After an accident to a ventilating fan within what time period must men be removed from the mine or affected areas?

38. Should ventilation be shifted from idle sections to active sections on different shifts?

39. While men are employed to provide the necessary amount of air, what other persons are permitted to enter the part of the mine affected?

40. When should changes in ventilation be made?

41. What is the maximum number of persons permitted to work on a single current of air?

42. How shall underground battery charging stations be housed and ventilated?

43. How shall underground motor generator sets be housed and ventilated?

44. How shall rotary converters be housed and ventilated?

45. How may rectifiers be ventilated?

46. How shall oil filled transformers be housed and ventilated?

47. How may air cooled, non-flammable liquid or inert gas filled transformers be ventilated?

48. What is the speed of a ventilating current called?

49. Why should excessively high velocities in a mine be avoided?

50. Why should extremely low velocities be avoided?

51. How may high velocities be avoided?

52. What must be overcome to pass a ventilating current through a mine?

53. What is mine resistance?

54. How does the mine resistance vary in relation to the velocity?

55. How can the mine resistance be decreased without decreasing the volume of air or changing its course?

56. What effect do constricted airways have upon mine resistance?

57. What effect do constricted airways have upon velocity when the volume of air remains constant?

58. What effect do constricted airways (reduce in area throughout length) have upon velocity when the ventilating pressure remains constant?

59. What is the ventilating pressure?

60. How is the ventilating pressure measured?

61. How is ventilating pressure produced by fans?

62. What effect do obstructions in airways have upon the quantity of air circulated, the fan speed remaining constant?

63. What effect do short circuits have upon the quantity of air circulated, the fan speed remaining constant?

64. What is meant by splitting a ventilating current?

65. What is an air split?

66. What effect does splitting the air have upon mine resistance?

67. What effect does a decrease in mine resistance have upon the performance of a fan?

68. What is the benefit of decreased mine resistance when it is not necessary to increase the quantity of air in circulation?

69. What effect does a cold intake current of air have upon the dampness of a mine?

70. What effect does high humidity and high temperature have upon persons working?

71. What are the two systems of ventilation?

72. How can the main haulway of a mine be placed on fresh air when the mine is ventilated by a force system?

73. What is the advantage of having the main haulway on the intake in the event of an explosion?

74. What is the main disadvantage of having the intake near the dumping point?

75. What must be done where coal is dumped near air intake openings?

76. What may be the disadvantage of having the coal shaft or slope on the intake during cold weather?

77. What may be the disadvantage of having workers on the return in a mine?

78. How would the temperature of the return air differ from the intake during the extreme hot or cold weather?

79. On what air currents shall haulage be placed?

80. How often and by whom must all main fans and machinery be inspected?

81. What quantity of air must reach the face of all working places?

82. If a bleeder is closed by water or a fall during pillar recovery operations, how much air must be added to the intake to permit work to continue?

STOPPINGS

83. What are stoppings?

84. What is the purpose of a stopping?

85. What is short-circuiting of the air?

86. What materials are used to construct stoppings?

87. What is rigid foam?

88. What are some of the advantages of rigid foam?

89. What kind of material shall be used to construct stoppings between return airways not required for the passage of air and equipment?

90. When should stoppings be completed?

91. What material should not be used to construct stoppings?

92. What are the principal requirements for permanent stoppings?

93. What effect do leaky stoppings have upon ventilation costs?

94. In what way do leaky stoppings increase the cost of ventilation?

95. What is the economical effect of airtight stoppings?

96. How can the ventilation of large abandoned areas be avoided?

97. When and where should brattice cloth stoppings be used?

98. What must be done with all workings which are abandoned?

99. How must stoppings be constructed to seal an abandoned area?

100. What should be done when conveyors are extended through stoppings?

LINE BRATTICE
&
AUXILIARY FANS

101. What is a line brattice?

102. What material is used for line brattices?

103. When brattice cloth is used, what precautions shall be taken against fire?

104. What is the purpose of a line brattice?

105. How should the space behind line brattices be maintained?

106. When greater velocity is required to remove gas at working faces, how should the line brattice be erected?

107. In continuous miner operations, what are the disadvantages of line brattices?

108. What are the advantages of properly installed auxiliary fans and tubing in continuous miner operations?

109. Under what conditions may auxiliary blower or exhaust fans be used?

110. Why must precautions be taken with auxiliary fans?

111. If an auxiliary fan stops, or fails, what action must be taken at the working face?

112. During the stoppage of the auxiliary fan, how must the working face be ventilated.

113. In places when auxiliary fans and tubing are used, how must faces be ventilated between shifts, weekends and idle shifts?

114. If the air passing through the auxiliary fan or tubing contains in excess of 1% CH_4, what immediate action must be taken?

115. What discretionary power (left to the judgment of) does the director have in regard to ventilation of faces when continuous mining machines are used?

116. If the director requires the use of diffuser fans, how long must they be kept in operation?

OVERCASTS

117. What is an overcast or undercast?

118. Why are overcasts generally preferred to undercasts?

119. How shall overcasts be constructed and maintained?

120. What are the main requirements of an overcast?

121. What are some of the common errors made in constructing overcasts?

122. How do overcasts aid haulage?

123. How do overcasts aid ventilation?

REGULATORS

124. What is a regulator?

125. What is the purpose of a regulator?

126. How is a regulator usually constructed?

127. What is the effect of closing a regulator on the quantity of air entering a split?

128. Why are regulators essential to the ventilation of a mine?

129. Who determines where regulators are placed?

130. Where are the regulators usually placed in a mine?

DOORS

131. What is the purpose of ventilating doors?

132. Why are doors in a mine objectionable?

133. How should a door be hung?

134. What provision should be made to prevent a short circuit of a main ventilating current?

135. How far apart should the doors of an air lock be placed?

136. When are doors advisable?

137. Should haulage equipment be permitted to stand in front of doors or curtains?

138. In what direction should doors swing to close?

139. Is the use of automatic doors preferable to ordinary doors?

140. Why should latches on doors be prohibited?

141. With what device should doors be provided for the detection of persons or trips on the other side?

142. What facilities should be provided for the passage of persons through doors where ventilating pressure prevents easy opening?

143. What should be the minimum dimensions of man doors in permanent stoppings or overcasts?

144. What locations should be avoided when placing doors?

145. What are the requirements relative to the construction of doors placed on main haulageways?

146. What precaution should a foreman take at the end of each shift to assure proper ventilation for his section?

147. At what intervals shall man doors be installed between intake and return airways?

148. In lieu of man doors at specified intervals in panels, where may man doors be provided?

CHECK CURTAINS

149. What is the purpose of check curtains?

150. Where should a curtain be used?

FANS

151. What causes air to circulate through a mine?

152. How is the difference in pressure between the intake and the return created?

153. What is meant by natural ventilation?

154. How is natural ventilation produced?

155. Why is natural ventilation not reliable?

156. What means of ventilation is prohibited in any mine?

157. What is the most reliable means of producing ventilation in a mine?

158. With what instruments should all main fans be provided?

159. What type of fans are in common use?

160. How does the centrifugal fan cause the air to circulate?

161. How does the axial flow fan cause air to circulate?

162. Where shall mine ventilating fans be located?

163. How must a mine fan installation be protected from an explosion?

164. What is the purpose of explosion doors?

165. How must fan buildings be constructed?

166. Where shall fans be located with respect to mine openings?

167. Under what circumstances may a fan be placed in front of or over a mine opening?

168. What electrical requirement is necessary for main fans?

169. Why should fans not be located in a mine opening?

170. How should man doors at fans be installed?

171. Why should mine fans be reversible?

172. How are mine fans made reversible?

173. What arrangements should be made to insure uninterrupted ventilation?

174. What is meant by mechanical efficiency of a fan?

175. For general purposes, what percentage of the power input to the motor can be considered to be applied to the fan shaft?

176. What is meant by the normal rated capacity of a fan?

177. How far may entries be driven from the outside before a fan is required?

178. What is meant by the rubbing surface?

179. What shape of airway is most efficient for ventilation?

180. How is the area of a circle calculated?

181. How is the perimeter of a circle calculated?

182. What is π?

183. What is the usual shape of mine airways?

184. What is meant by the perimeter of an airway?

185. What is the cross-sectional area of an airway?

186. What factors determine the mine resistance?

187. What is the coefficient of friction?

188. How can the rubbing surface of an airway be calculated?

189. How can the unit ventilating pressure of a mine be calculated?

190. When calculating the unit ventilating pressure of a mine, what unit of pressure is determined?

191. How does the mine resistance vary with respect to the perimeter and area of the airways?

192. How is the quantity of air in a ventilating current determined?

193. How is the total mine pressure calculated?

194. How can the power required to move a ventilating current be determined?

195. How does power vary in relation to the velocity?

196. How is calculation made to find the horsepower required to move a ventilating current?

197. What is horsepower?

198. If an airway is 12 feet wide and 6 feet high, what is the area?

199. If the area of an airway is 60 square feet and the quantity of air is 30,000 cubic feet per minute, what is the velocity?

200. An airway fourteen feet wide and four feet high is passing twenty-five thousand (25,000) cubic feet of air per minute. What is the velocity?

201. What is the quantity of air passing through an airway 10 feet wide and 5 feet high, if the velocity is three hundred (300) feet per minute?

202. If an airway is 8 feet wide and 4 feet high, what is the perimeter?

203. What is the rubbing surface of an entry 12 feet wide, 5 feet high and 5,000 feet long?

204. If the quantity of air in the main return is two hundred thousand (200,000) cubic feet per minute and the methane content is seventy-five-hundredths per cent (0.75%), how many cubic feet of methane is liberated by the mine each day?

205. If the return air current of a mine consists of fifty thousand (50,000) cubic feet per minute and contains eight-tenths per cent (0.8%) of methane, how much air must be added to reduce the methane to five-tenths per cent (0.5%)?

SAMPLE QUESTIONS FOR VENTILATION

1. How often shall bleeder entries be examined by a certified person designated by the operator?
    a. Every 7 days is adequate with a record made of the examination in a book provided for that purpose
    b. Semi-annually is sufficient with a record of the examination
    c. Every 90 days by a certified person
    d. At least once each week and a record of the examination shall be recorded in a book specified for that purpose
    e. None of the above

2. A volume of 24,000 cubic feet of air and gas at its most violent explosive point is traveling in an airway. How much air should be added to reduce the methane content to one percent?
    a. 2,600 feet per minute
    b. 150,000 cfm
    c. 66,500 cfm
    d. 216,000 cfm
    e. I don't think any answer is correct because the units don't match volume vs. volumetric rate.

4. What is the cross section area of an entry 12 feet, 3-1/2 inch high and 200 inches wide, approximately?
    a. 600 square feet
    b. 604 square feet
    c. 605 square feet
    d. 615 square feet
    e. None of the above

5. If the area of an airway is 84 square feet and the quantity of air is 63,000 cubic feet per minute, what is the velocity?
    a. 630 feet per minute
    b. 700 feet per minute
    c. 750 feet per minute
    d. 840 feet per minute
    e. There is not enough information to compute an answer

6. Regulators are placed in a mine at the following places _____.
    a. Return air at the portal
    b. At the air split
    c. In the return heading of each split of air
    d. None of the above

7. An anemometer is used to measure _____.
    a. Air velocity
    b. Electrical amperage
    c. Methane present
    d. Air quantity
    e. Atmospheric pressure

8. The main purpose of sealing off fire areas in the mine is _____.
    a. Oxygen starvation
    b. Control explosive gases
    c. Contains the fire
    d. All of the above

9. How many square feet of rubbing surface are in an airway 6 feet high, 19 feet wide, and 2,500 feet long?
    a. 285,000 square feet
    b. 279,650 square feet
    c. 62,500 square feet
    d. 125,000 square feet

10. How often shall the results of the main fan inspections be recorded in a fan inspection book approved by the Secretary?
    a. When the weekly fire boss examinations are recorded
    b. Daily, after the inspections have been completed
    c. After each 8 hour examination has been completed
    d. Every two weeks
    e. None of the above

11. The area surrounding all main fans should be kept free of combustible material for at least _____ feet in all directions.
    a. 50 feet
    b. 100 feet
    c. 200 feet
    d. 125 feet
    e. None of the above

ANSWER SHEET FOR
VENTILATION GENERAL

1. To provide sufficient pure air to the employees and to dilute, render harmless, and carry away all the dangerous and noxious gases.
2. At lest two (2).
3. Fifty (50) feet.
4. One hundred (100) feet.
5. Three hundred (300) feet.
6. Ample ventilation is required in all mines where one or more persons work.
7. By the use of fans, mechanically operated.
8. Two hundred (200) feet
9. Continuously throughout its operating life.
10. A stoppage of the ventilating current may permit the accumulation of dangerous or noxious gases.
11. 19.5 per cent.
12. 0.5 per cent carbon dioxide.
13. No harmful quantities.
14. Nine thousand (9000) cubic feet per minute except on pillar sections where it may be less.
15. Nine thousand (9,000) cubic feet per minute.
16. By coursing the air through the intake airways to the working faces and returning it to the outside by the return airways.
17. Twelve thousand (12,000) cubic feet per minute.
18. That it be unobstructed, fireproof, and located away from possible sources of contamination to the air.
19. That they are of sufficient area and kept free from obstructions.
20. Insufficient area and falls restrict the volume and increases the resistance, resulting in inefficiency.
21. By the use of stoppings, doors, overcasts, undercasts, regulators, check curtains, line brattices and auxiliary fans.
22. Through abandoned workings not regularly inspected or air which has been used to ventilate a pillared section.
23. Line brattice. Auxiliary fans and other approved methods of ventilation should be used and 12,000 cubic feet of air delivered to the last open breakthrough.
24. Line brattice or other approved methods of ventilation should be used.
25. Ventilation is uncertain and gas may accumulate.
26. In advance of the ventilating current.
27. By keeping the ventilating current along the pillar line.
28. Such men should be withdrawn immediately.
29. Two hundred (200) feet.
30. Twelve thousand (12,000) cubic feet of air per minute.
31. As often as necessary to insure adequate ventilation.
32. At the inlet and outlet near the faces in advanced headings.
33. A careful watch should be kept over them.
34. The men shall be ordered to withdraw from the affected areas immediately and the power disconnected.
35. Ventilation must be restored and the mine thoroughly examined and reported safe.

36. A certified person.
37. Fifteen minutes.
38. No.
39. No person, except those actually employed in the necessary repair work.
40. When the mine is idle.
41. Eighty persons with a permit.
42. In a fireproof building ventilated by a separate split of air direct to the main return except that portable or semi-portable battery charging units may be operated on intake air if a minimum of 15,000 cubic feet per minute is circulating for one tray of batteries and 5,000 cubic feet of air per minute additional for each tray added.
43. They shall be housed in a fireproof building and ventilated by a separate split of air.
44. They shall be housed in a fireproof building and ventilated by a separate split of air.
45. They may be ventilated on the intake air.
46. They shall be housed in a fireproof building and ventilated by a separate split of air.
47. They may be ventilated on the intake air.
48. The velocity.
49. High velocities increase the necessary ventilation pressure and power consumption, keep coal dust in suspension, and may cause discomfort to the workers.
50. Low velocities will not properly sweep out the gases.
51. By the use of airways of adequate cross-sectional area and by splitting the air current.
52. The mine resistance.
53. The resistance of the surfaces, bends, and obstructions in the airways to the passage of air.
54. The mine resistance varies directly as the square of the velocity.
55. By enlarging or cleaning the airways.
56. Constricted airways increase resistance by offering a greater proportion of rubbing surface for the effective area and by requiring increased velocity of a given quantity of air.
57. The velocity is increased in inverse proportion to the area.
58. The velocity of the main ventilating current is decreased.
59. The ventilating pressure is the pressure, which must be exerted upon an air current to overcome the mine resistance.
60. With pressure-recording gauges or water gauges.
61. By the speed at which the fan is operating. (Varying with the characteristics of the fan).
62. The quantity is decreased.
63. The quantity is increased.
64. Dividing the main current into separate individual currents.
65. A portion of the main ventilating current forming a continuous current throughout a definite part of the mine.
66. The mine resistance will be decreased.
67. The fan is enabled to circulate an increased quantity of air with no increase in the ventilating pressure.
68. A saving in power can be effected by reduced fan speed.
69. As the temperature of the air rises moisture is absorbed and the mine surfaces become dry.
70. The temperature of the body can not be dissipated by the evaporation of perspiration and such conditions cause discomfort to the workers.
71. Blowing (force) and exhaust.
72. By the use of air locks or by placing on a separate split.
73. Usually Entrance to the mine is more easily obtained.
74. Dust from the dumping point is frequently carried into the mine.

75. Reasonable provisions must be made to prevent dust from entering the mine.
76. Freezing temperatures may interfere with operation.
77. The return may contain an explosive mixture of gas.
78. Temperatures of the return are usually moderate.
79. On the intake.
80. Daily by a certified electrician.
81. 3,000 cfm—or as much or more to render harmless and carry away all dangerous mixtures of gases.
82. 11,000 cfm, a total of 20,000 cfm.

ANSWER SHEET FOR STOPPINGS

83. Partitions erected across openings.
84. To prevent short-circuiting of the air or to seal off portions of the mine.
85. Permitting it to enter the return before reaching the faces.
86. Concrete, brick, tile, brattice cloth, plastic, metal, and rigid foam.
87. Rigid foam is a stiff cellular material formed when two liquid chemical compounds are mixed in a specially designed spray gun and sprayed on to a surface such as concrete, steel, wood burlap, rock, or coal.
88. It is an excellent sealing material, is strong enough to be able to be sprayed on brattice cloth or wire mesh. Resists crushing, and is easy to apply.
89. Incombustible or fire resistive material.
90. They should be completed promptly, as required
91. Gob.
92. They should be airtight, and substantial.
93. Costs are increased due to waste of the air.
94. By requiring the fan to move a greater quantity of air than necessary to properly ventilate the working faces.
95. Costs are decreased by an increase in ventilating efficiency.
96. By sealing them. (Open abandoned areas require ventilation and frequently the oxygen supplied to such areas combines with carbonates to form CO, or may be the cause of spontaneous combustion. Abandoned areas should be effectively sealed, unless they are accessible and can be examined regularly.
97. Only temporarily, in next to the last open breakthrough.
98. They must be sealed or ventilated.
99. The sealing shall be done with incombustible material in a manner prescribed by the Director of Mines; and one or more of the seals shall be fitted with a pipe and a cap or valve to permit the sampling of gases and measuring of hydrostatic pressure behind the seals.
100. They should be boxed to prevent excessive air leakage.

ANSWER SHEET FOR
LINE BRATTICE & AUXILLARY FANS

101. It is a curtain erected from the last breakthrough, along the entry or room to the face.
102. Brattice cloth or incombustible material.
103. The brattice cloth shall be flame resistant.
104. To assure a sufficient velocity of air at the face to remove dangerous gases and smoke from explosives.
105. Clean and open for the free flow of air.
106. The intake air current could be restricted, thereby creating a greater velocity.
107. Line brattice cannot be extended in by the machine and therefore does not conduct the air current to the face where it is needed.
108. The air can be directed to the face where needed.
109. (1) When powered by permissible driving units.
(2) Operated continuously while work is being performed in the area being ventilated.
(3) Placed so that recirculation of the air is not possible.
(4) The inby end at the tubing or line curtain shall be kept sufficiently close to dilute, render harmless and carry away all dangerous gases.
110. Because they may re-circulate the air, they constitute a fire hazard, their intermittent use may permit accumulations of gas.
111. Face equipment must be stopped and power disconnected at the source.
112. By the primary air current being directed to the face by a line curtain.
113. By the primary air current directed to the face by means of line curtain.
114. The current switched off the machine and the cable disconnected at the source (until pronounced safe again.)
115. When using auxiliary fans and tubing the machine shall be provided with a machine mounted diffuser fan.
116. Continuously while the machine is in operation.

ANSWER SHEET FOR
OVERCASTS

117. It is an enclosed airway constructed to provide means for one air current to cross another.
118. Undercasts might be easily filled with debris or water and are therefore seldom used unless it is not practical to construct an overcast.
119. Constructed of incombustible material and maintained in good condition.
120. To provide sufficient area for the air current and to permit a smooth, uninterrupted flow of the air.
121. Rough and abrupt interruptions to the ventilating current, and insufficient area.
122. They eliminate the necessity for doors on the haulage road.
123. They permit frequent splitting of the air allowing air to pass only over one section or one portion of a mine.

ANSWER SHEET FOR REGULATORS

124. A variable partial obstruction in an airway.
125. To control the distribution of the air by regulating the resistance to flow in an air split.
126. It usually is a stopping provided with an opening having a sliding door.
127. The quantity is decreased.
128. They proportion the air to meet the requirement of each individual split.
129. The mine foreman.
130. In the return headings of each split of air.

ANSWER SHEET FOR DOORS

131. To direct the course of the ventilation and permit traffic to pass.
132. If damaged or left open they permit short-circuiting of the air, they permit breakage, and unless built of incombustible material, they constitute fire hazard.
133. So that it will close automatically and tightly.
134. Doors shall be hung in pairs to form air locks unless mechanically operated. This is a legal requirement.
135. At sufficient distance to accommodate a full trip of cars.
136. Where it is impracticable to use overcasts.
137. No, never.
138. In the direction of the air current.
139. Yes, but they should be inspected regularly and kept in operating condition.
140. Because doors should not be provided with a device to prevent their closing.
141. Small windows.
142. Man doors on the clearance side.
143. Thirty(30) inches square.
144. Doors should be avoided on main haulageways when possible.
145. They should be built substantially and hung to close automatically.
146. See that the doors on his section are closed.
147. 500 feet when the height of the coal is over 48 inches, 300 feet when the height of the coal is under 48 inches.
148. Provision may be made for entrance into the main return near the mouth of each set of panel entries.

ANSWER SHEET FOR CHECK CURTAINS

149. To deflect the air current from entries into working faces.
150. Only within the limits of an active working section where leakage is not detrimental.

ANSWER SHEET FOR
FANS

151. The difference in pressure between the intake and the return.
152. By difference in temperature, elevation, or by mechanical means.
153. Movements of air produced by difference in the weights of air columns or by difference in temperature.
154. By the difference in weight of air due to the difference in temperature between outside air and mine air or by difference in pressures.
155. The direction may reverse with weather conditions, and when the outside temperature approximates the inside temperature, movement may cease.
156. Ventilation by means of furnace.
157. A mechanically operated fan.
158. Pressure recording gages or water gages.
159. The centrifugal and axial flow fans.
160. Air is drawn in at the sides and discharged centrifugally with velocity and pressure
161. Air is drawn in at the sides and discharged centrifugally with velocity and pressure.
162. On the surface.
163. By explosion doors, or a weak wall.
164. To relieve the pressure of an explosion before it reaches the fan.
165. With incombustible material, equipped with fireproof air ducts and provided with explosion doors or a weak wall.
166. They should be offset not less than fifteen (15) feet from the nearest side of the mine opening and connected to the opening by means of air ducts.
167. When the opening is not in a direct line with possible forces coming out of the mine if an explosion occurs and there is another opening having explosion doors or a weak all in direct line of forces coming out of the mine.
168. They must be operated from an independent power circuit.
169. Because of the possibility of their destruction in the even of a mine explosion.
170. In pairs to form an air lock.
171. So that the air current can be reversed in case of fire or explosion, if deemed advisable.
172. By an arrangement of air doors in fan housing or in the mine, or by changing the direction of rotation or disc fans.
173. Emergency fans or emergency power units should be provided.
174. It is the ratio of the actual horsepower output in air to the actual horsepower applied to the fan shaft.
175. About eighty (80) per cent.
176. It is the capacity specified for it by the manufacturer at which the best efficiency is obtained.
177. Two hundred (200) feet
178. The surface of an airway in contact with the current.
179. A circle.
180. $A=\frac{\pi d^2}{4} = .7854d^2$ or πr^2 or $\frac{22r^2}{7}$
181. Perimeter $=\pi d$ or $2 \pi r$.
182. 3.1416. (The ratio of circumference to the diameter of a circle).
183. A trapezoid.
184. The distance as measured around its cross-sectional area.

185. The number of square feet enclosed within its perimeter.
186. The area, perimeter and length of the airways, the velocity and the coefficient of friction.
187. The resistance of one square foot of rubbing surface to an air current with a velocity of one foot per minute.
188. Multiply the length by the perimeter.
189. By multiplying the coefficient of friction by the product of rubbing surface of airways and the square of the velocity and dividing by the area. ($\frac{p=k1ov^2}{a}$)
190. The pressure in pounds for each square foot of sectional area.
191. The mine resistance varies as the perimeter divided by the cube of the area.
192. By multiplying the area of an airway by the velocity in feet per minute.
193. By multiplying the unit pressure by the cross-sectional area of the airways.
194. The power, in terms of foot pounds per minute. Is determined by multiplying the unit pressure by the quantity of air per minute.(u=pq)
195. Power varies as the cube of the velocity.
196. By dividing the foot pounds per minute by 33,000 (H.P.= $\frac{u}{33,000}$)
197. The work required to raise 33,000 pounds one foot per minute.
198. 72 square feet. A= 12 x 6 =72 square feet.
199. 500 feet per minute. A= 60 sq. ft. q=30,000 cu. ft. q=av or
v=$\frac{q}{a}$ = $\frac{30,000}{60}$=500ft. per minute
200. 446.4 feet per minute. A=14 x 4 =56 q=25,000cu. ft. v=$\frac{q}{a}$ $\frac{25,000}{56}$ =446.4 ft. per minute
201. 15,000 cubic feet per minute. A =10 x 5= 50sq. ft. v= 300 ft. per minute
q=av = 50 x 300 = 15,000 cubic ft. per minute
202. 24 feet p = 2(8) + 2(4)= 24 feet
203. 170,000 sq. ft. o = 2(12) + 2(5) = 34 ft , l = 5,000 ft.
S = lo = 34 x 5,000 = 170,000 sq. ft.
204. 2,160,000 cubic feet. 200,000 x 0.0075 = 1,500 cubic feet of methane per minute
60 x 24 =1440 minutes per day. 1,500 x 1,440 = 2,160,000 cubic feet of methane per day.
205. 30,000 cubic feet per minute.
Methane produced per minute = 50,000 x 0.008=400 cubic feet.
Total volume with 0.5% methane = $\frac{400}{0.005}$ = 80,000 cubic ft.
Additional Air Required = 80,000 - 50,000 = 30,000 cubic feet per minute

ANSWER SHEET FOR VENTILATION

1.	a	6.	a
2.	d	7.	a
3.	e	8.	d
4.	c	9.	b
5.	c	10.	b

CHAPTER THREE

GENERAL MINING PRACTICE

1. Coal
2. General Safety
3. Belts and Conveyors
4. Haulage
5. Timbering
6. Coal Dust
7. Drainage
8. Shafts and Slopes
9. General Mining

GENERAL MINING PRACTICES – COAL

1. What is the generally accepted theory for the origin of coal?
2. What are the general ingredients of coal?
3. What are the principal heat producing constituents of coal?
4. What is volatile matter in coal?
5. What is ash?
6. What undesirable elements exist in coal in varying small quantities?
7. Why is sulphur undesirable in coal?
8. What is the general specific gravity of coal?
9. What is the average weight of solid coal per cubic foot?
10. How many net tons (2,000 lbs.) are generally considered to be in a foot acre?
11. What is a B.T.U.?
12. How is the heating value of coal usually expressed?
13. When planning the layout of a mine, what governs the width of rooms and pillars?
14. What are the principal systems of mining in Utah?
15. Which is more desirable for a large mine, a double entry system or a multiple entry system?
16. Why is a multiple entry system more desirable than double entries?
17. Why is the complete extraction of pillars practiced?
18. Why is complete extraction of pillars not always practiced?
19. What may be the result of an irregular pillar line?
20. What is the panel system?
21. What are the practical advantages of the panel system?
22. What may be the result of wide rooms and standing narrow pillars?
23. Why should pillars be extracted in proper sequence?

24. What is the main consideration in obtaining good falls on a pillar line?

25. Why should ample pillars be left along haulageways?

26. What is a squeeze?

27. What is a creep?

28. How can a squeeze be avoided?

29. How can a creep be stopped?

30. What is a bump?

GENERAL SAFETY

31. Why were the mining laws enacted?

32. What is the requirement as to access, from the interior of the mine to escapeways to the surface.

33. How shall the direction to outlets or escapeways be marked?

34. Where shall mine foremen be employed?

35. What qualifications of citizenship are required of a mine foreman?

36. What length of experience is a person required to have in the working, ventilation and drainage of coal mines, to be eligible for a mine foreman's certificate?

37. How does a person secure a mine foreman's certificate?

38. Upon the death or resignation of a mine foreman, who should be appointed?

39. Who is responsible for acts of the assistant foreman?

40. How often shall entrances to old workings be traveled and examined?

41. How often shall airways be traveled and examined?

42. By whom should an official be accompanied when exploring abandoned workings not regularly inspected at least once each week?

43. What instrument should be carried by an official exploring abandoned workings?

44. What shall be done at entrances to dangerous places in a mine?

45. What shall be done when dangers are reported?

46. In case it is impracticable to remove a danger, what shall be done?

47. What shall be available at all times for the proper maintenance of the mine?

48. When the mine foreman is unable to comply with any of the requirements of the mining law, what action shall be taken?

49. Under what conditions shall a person other than those in an official capacity be prohibited from entering a mine on idle days to perform work?

50. To whom shall entry into a mine, idle or working, be limited?

51. When may persons, other than certified officials, pass across danger boards?

52. When may certified official pass across danger boards?

53. From what use are fuels which generate dangerous gas prohibited in mines?

54. What haulage power is prohibited from use in a producing mine?

55. What kind of beverages shall not be taken into a mine?

56. How close to adjoining properties may excavations be made?

57. When may excavations be made to the dividing line of adjoining properties?

58. How far from the abandoned areas shall the boreholes be started?

59. Why are safety rules necessary for the guidance of mine employees?

60. How does the enforcement of safety rules prevent accidents?

61. Why should employees assist in offering suggestions relative to safety rules?

62. What benefits can be secured from safety meetings?

63. Why should safety rules be enforced?

64. What method shall be adopted and maintained to advise employees of the rules and regulations of the mine?

65. What is the minimum legal age of employment in or around the mines?

66. What is the duty of the mine foreman relative to new employees?

67. How is an inexperienced person required to work until he is familiar with the dangers incident to his work

68. What regulation shall be placed on men entering and leaving mines?

69. Why should all injuries, even those of a trivial nature, be reported?

70. How shall the scene of a fatal accident be left?

71. What shall be worn as head and foot protection?

72. What protection shall be provided for the eyes when grinding, cutting, welding, or striking where particles may fly?

73. What is the principal hazard connected with grinding or pouring hot metal?

74. What protection should be provided for men exposed to falling from elevated structures?

75. What is the danger of loose clothing?

76. What safety device should be worn by men working in or near the top of shafts or other deep excavations?

77. What is the most common cause of serious injuries to persons working with mobile machinery?

78. What is the duty of machine runners and helpers relative to others in the vicinity while the machine is in operation?

79. When shall the cutting machine not be moved?

80. What protective devices should be provided for cutter chains and the arms and chains of loading heads?

81. Why should refuse or material be prohibited from accumulation along a passageway?

82. In what condition should mines be kept?

83. How should illuminating and signal lights be maintained?

84. Why should others than those familiar with a piece of equipment be prohibited from attempts of operation?

85. What protective devices should be used on gears, belts, and revolving parts of stationary machinery?

86. What precaution should be observed when reassembling a machine with dangerous contacts or moving parts?

87. What precautions shall be taken before starting machinery where two or more persons work?

88. What precautions should be taken with machinery and equipment raised for repairs?

89. Why are repairs, adjustments or oiling of moving machinery prohibited?

90. What should not be permitted to accumulate on machinery?

91. What shall be done with defective machinery or equipment?

92. What precaution should be taken when pipe is heated?

93. How should wire ropes be maintained?

94. How should rollers on inclines and rope haulage be maintained?

95. What danger exists when the employee is equipped with defective or improper tools?

96. Who should be responsible for the condition of hand tools?

97. What materials should not be permitted to accumulate in structures in and about mines?

98. What protective devices shall be provided for repair pits in floors or ground?

99. What protective devices shall be provided for stairways, landings, and elevated platforms?

100. From what materials shall steps, landings and platforms be kept free?

101. How shall steps, landings and platforms be maintained?

102. What should be prohibited from places where oil and grease are kept?

103. Where shall welders and torches not be used?

104. How often shall the mine foreman or his assistants visit and carefully examine each working place?

105. What shall be done when excavations are driven toward and in dangerous proximity to an abandoned mine suspected of containing flammable gas or dangerous quantities of water?

106. What protection against fires shall be provided where grease or oil are kept or used in quantities?

107. What shall be done before welders or torches are used near the working face?

108. What shall a mine foreman do when he finds a place in dangerous condition?

109. If the outlets from a mine are shafts, what shall be provided for persons to escape from the mine in case of an accident?

110. If equipment is mobile, what must be done before cutting or welding may be performed on such?

111. What training requirement must be met concerning self rescuers?

112. Where shall first aid equipment be provided?

113. What requirement must be met when transporting a sick or injured person to the surface?

114. When should employees wear approved goggles or eye shields?

115. Who is responsible for safety in all coal mines?

BELTS AND CONVEYORS

116. What shall be provided where men load or unload on conveyor belts?

117. What is maximum speed of belt permitted when men are being transported?

118. When must men not ride on belts?

119. How far apart must men be spaced when riding belts?

120. What is the minimum roof clearance when men ride belts?

121. When the height of the coal seam permits what shall the clearance be?

122. What safety factor shall be present when men ride belts?

123. Who shall supervise the loading and unloading of belts used for transporting men?

124. Where men cross over belts regularly, what is required?

125. What shall be installed along all belt conveyors used to transport men?

126. What material is required of belt conveyors after July 1, 1971?

127. Where are start and stop controls required for conveyor belts that do not transport men?

128. What fire protection is required at all belt drives?

129. What shall be the clearance on sides of belts?

130. When shall belt conveyors be inspected?

131. What should an inspection of a belt conveyor include?

HAULAGE

132. What is the second greatest cause of fatalities in coal mines?

133. What approximate percentage of fatalities is attributable to haulage?

134. What are some of the unsafe haulage practices?

135. What should be done along haulage roads, slopes and engine planes, to permit persons to pass moving cars with safety?

136. What clearance shall be maintained on the "safety side" along entries between the car and the rib, gob or timber, for the passage of persons?

137. Where shall the clearance side along a track be located relative to the trolley wire?

138. What minimum clearance shall be maintained on the wire side ("tight side") between the car and the rib, gob or timber?

139. What shall be the clearance where supplies are unloaded?

140. What provision should be made relative to leaving supplies along a haulage track?

141. What shall be the minimum clearance along each track in sidetracks?

142. What protection shall be provided for pedestrians along haulageways?

143. What shall be the maximum distance between shelter holes?

144. What is the minimum size required for shelter holes?

145. How shall shelter holes be maintained?

146. How should shelter holes be placed relative to the track?

147. When should shelter holes be used?

148. What should a person do before stepping out of a shelter hole immediately after a trip has passed?

149. How are moving trips required to be lighted?

150. Who shall see that a conspicuous light is placed on the front and rear of every trip?

151. Who shall provide a conspicuous light on the front and rear of every trip?

152. How shall a "light" locomotive be lighted?

153. How should the brakes on locomotives be maintained?

154. How should the sand rigging on locomotives be maintained?

155. What material should be provided on each locomotive to increase traction?

156. How should the decks of locomotives be protected from moving parts and loose material in the track?

157. What signaling devices shall be provided on locomotives and shuttle cars?

158. What appliance is required as equipment for a locomotive?

159. What is the duty of the motorman relative to the speed of transportation?

160. Where should the operator of a locomotive be while the locomotive is being operated?

161. In what manner shall trips not be operated on main haulageways?

162. How should motormen operate trips when approaching and passing through doors or curtains?

163. What protection shall be provided for trips, locomotives and other mechanically operated equipment coming out onto tracks used by other portable equipment?

164. What shall be done to regulate and safeguard the movement of trips?

165. What precaution should be taken before current is connected to locomotive or controller is opened?

166. What precaution should be taken in making up trips to haul rail, pipe or long supplies?

167. What precautions should be observed before motormen leave locomotives?

168. What are the specific duties of motormen and brakemen relative to ventilating doors?

169. What is the duty of the motorman relative to spotting cars near a door or curtain?

170. What is the duty of the motorman relative to unsafe places along the haulageway?

171. What precautions should be observed while cars are being delivered to the working face?

172. How shall a man-trip be operated?

173. At what speed shall a man-trip be operated?

174. When is back-poling allowed?

175. Why should back-poling be avoided?

176. For safety, how should mine cars be maintained?

177. To what height should cars not be cribbed?

178. When should man-trips not be operated on long heavy grades?

179. Who shall supervise the operation of man-trips?

180. In what manner should man-trips not be operated?

181. What type of cars shall not be used in man-trips?

182. What are the duties of motormen and trip riders relative to persons riding on locomotives or loaded cars?

183. Who, other than those necessary for operation, may ride on loaded cars or on the outside of a car?

184. On which side shall men not ride?

185. Where only shall trip riders ride on bumpers?

186. From what side should cars not be coupled?

187. How may mine cars be coupled in safety?

188. How should clearance points at the end of sidetracks be designated?

189. Where should cars, locomotives or other portable machinery not be placed on sidetracks?

190. Where should loaded cars not be stored?

191. What are the primary requirements of good mine track?

192. What hazards are attendant to poorly maintained track?

193. What are the primary causes of haulage accidents?

194. What should be the condition of track at working faces before cars are placed?

195. Why should track be properly maintained at working faces?

196. In what condition should haulageways and travelways be maintained?

197. What are the practical advantages of having properly installed turnouts?

198. What should be a requirement of switch throw ties?

199. Where shall switch throws be located?

200. What kind of switch throws are safest?

201. How should switches be kept aligned?

202. What safety precautions should be observed where track goes to the rise or to the dip?

203. What devices should be provided at each working face to prevent the car from moving?

204. When a trip is uncoupled from a locomotive on a grade, what precautions should be taken?

205. How can the size of a frog be determined?

206. Knowing the gauge of track and the number of the frog, how can the approximate lead or the distance from the point of frog to the point of switch be determined?

207. How can the radius or curve of a properly installed turnout be determined, if the number of the frog and track gauge are known?

208. What is meant by track gauge?

209. What protection from moving trips shall be provided on both sides of permanent doors?

210. What are required at locations along haulage roads where there are abrupt or sudden changes in the overhead clearances?

211. Where pusher locomotives are not used, what is required?

212. Who is permitted to ride on locomotives or loaded cars?

213. When shall a dispatcher be employed?

214. What duties other than to direct traffic does the dispatcher have?

215. Where shall dispatcher stations be provided?

216. What equipment shall be equipped with two way communications?

217. Can oxygen or gas tanks be transported in conjunction with a man trip?

218. What requirement relative to hoses and gauges should be observed while oxygen or gas tanks are being transported?

219. Who shall supervise the movement of equipment other than ordinary sectional moves?

220. How many persons shall be permitted to be inby equipment being moved other than ordinary sectional moves?

TIMBERING

221. What is the cause of the majority of fatalities in coal mines?

222. What approximate percentage of fatalities is caused by falls of roof and coal?

223. What shall each mine have relative to roof control?

224. How may falls of slate and roof be controlled?

225. What should each employee, or the official in charge, do before work is started?

226. What shape does a weak, tender roof assume in an entry after all the loose material has fallen?

227. How is the strength of the roof affected by moisture?

228. What are the main requirements of good timbers?

229. What should be the length of timbers delivered to the working places?

230. What should be the condition of timbers delivered to working places?

231. When should broken, rotten or inferior timbers be replaced?

232. What timbers shall be furnished?

233. What shall a mine foreman do when he finds a place in a dangerous condition?

234. When should a miner be prohibited from working in his place?

235. How should machine men protect themselves from falls of roof, while making a cut?

236. What should be done before new places or slabs are started?

237. What shall be done with loose, dangerous, or unusual overhanging ribs or brows or roof?

238. How should timbers be placed with respect to the track?

239. When setting crossbars or taking down loose rock, what precaution should be taken?

240. Where must safety posts, jacks or temporary crossbars be set?

241. Of what kind of wood should cap pieces be made?

242. What protection is a cap piece to a timber?

243. What are the advantages of using a cap piece under a prop?

244. What method of timbering should be used when there are numerous fractures in the roof or it is extremely weak?

245. What is a crossbar?

246. What are common errors made in setting timbers?

247. How should a post be set in a pitching place?

248. How should a person removing a post be protected?

249. When should a post puller be used?

250. What manner of removing timbers should not be permitted, particularly in retreat work?

251. What is the greatest danger from pillaring operations?

252. How can the danger of roof falls in pillaring operations be lessened?

253. What is the proper method of testing roofs?

254. What is the most dangerous roof?

255. What is a kettle bottom?

256. What form of hand tool should be used in taking down slate?

257. What tool should not be used to take down slate or drive wedges?

258. What is roof bolting?

259. What material is used to tie the strata together?

260. What is required before roof bolting plan is approved?

261. What should be done when adverse roof conditions are encountered?

262. In mines, where can roof bolts be used?

263. In roof bolting what length of bolts should be used?

264. In roof bolting what diameter bolts shall be used?

265. In roof bolting how shall bolts be anchored?

266. In roof bolting what size plate shall be used?

267. In roof bolting how far apart shall bolts be placed?

268. What is torque?

269. How tight should roof bolts be installed?

270. In roof bolting how should bolts be tightened?

271. How can the torque on a roof bolt be determined?

272. What is tension on a roof bolt?

273. How can the tension on a roof bolt be approximated?

274. What is torque “Bleed off”?

275. What causes torque “bleed off”?

276. When shall roof bolts not be recovered?

277. How often must the roof support plan be reviewed for each mine?

278. Who shall review the roof support plan for each mine?

279. Where shall the approved roof support plan be posted?

COAL DUST

280. What causes the propagation of explosions throughout large areas of mines?

281. How does coal dust contribute to the severity of an explosion?

282. When is it possible to have an explosion in a coal mine with no methane present?

283. Under what circumstances does coal dust explode?

284. What are the main causes of a coal dust explosion?

285. How much coal dust is sufficient to propagate a coal dust explosion?

286. What are the largest size particles of coal dust which will start an explosion?

287. Which coal dust will not explode?

288. What effect does fineness of coal dust have upon its explosibility?

289. Will damp coal dust explode?

290. How can the explosibility of coal dust be reduced?

291. What is the maximum amount of moisture that coal dust will retain?

292. What is the principal explosion hazard in tipples?

293. What shall be done with accumulations of fine, dry coal dust in a mine?

294. How should dry and dusty operating sections be treated?

295. What benefit is derived from rock dusting?

296. What kinds of rock dusts should be used?

297. What is the maximum percentage of silica in rock dust?

298. What shall be the size of rock dust?

299. How close to working faces must rock dust be applied?

300. What additional percentage of rock dust should be used when methane is present?

301. What should be done before fine coal dust is loaded from haulageways?

302. How shall unusual quantities of coal dust be kept out of suspension?

303. Who shall approve methods of allaying dust in mines?

304. Who shall be required to wear respirators?

305. What shall be the condition of tipples and cleaning plants relative to coal dust?

306. After applications of rock dust are made in a coal mine, how may the incombustible content on the mine be determined?

307. What effect does the presence of small amounts of methane have upon the explosiblity of coal dust?

308. What effect does the volatile matter in coal have upon its explosibility?

309. What entries shall be rockdusted?

310. What shall be the minimum percentage of incombustible material after rockdust has been applied?

DRAINAGE

311. What is the requirement relative to water drained from mines or coal washeries into streams?

312. What are the duties of the mine foreman relative to drainage?

313. How shall travelways , haulageways, and escapeways be maintained?

314. What may be the effect of undrained bodies of water upon ventilation?

315. What are the disadvantages of poorly drained mines?

316. How can a mine be kept free from water?

317. What is the weight of one cubic foot of water?

318. What is the pressure exerted by a column of water one foot high and on one square inch of surface?

319. How many gallons are in one (1) cubic foot?

320. What is the weight of one (1) gallon of water?

321. What is the theoretical height to which water can be lifted in a vacuum by atmospheric pressure by sea level.

322. What is the practical height to which water can be lifted in a siphon at sea level?

323. What is a siphon?

324. What practical precautions must be taken in the installation of a siphon line to insure its operation?

325. What is the principle upon which the siphon operates?

326. What two types of pumps are generally used in coal mines?

327. What particular type of pump is best adapted for gathering service?

328. Why is a centrifugal pump not so well adapted for gathering service?

329. What resistance must be overcome when a pump is in operation?

330. A pump is discharging from a sump, six hundred and ten (610) feet vertically below the surface. Assuming a friction head equal to ten percent (10%) of the static head, what is the total pumping head?

331. What H.P. would be required to pump four hundred (400) gallons per minute to an elevation of three hundred (300) feet assuming the friction loss in the pipes amounted to fifteen percent of the static head?

332. How long would it take 40 H.P. to pump eighty-eight thousand (88,000) gallons to a total head of three hundred and sixty (360) feet?

SHAFTS AND SLOPES

333. What condition of maintenance is required for hoisting machinery used for lowering or hoisting persons?

334. What condition of maintenance is required for ropes, sockets and clamps?

335. How often are inspections required for hoisting machinery used for lowering or hoisting persons?

336. How often should hoisting ropes be resocketed and have rope dressing applied?

337. How often should overwinding devices be tested?

338. How often should safety catches be tested?

339. How many wraps of rope should always remain on a hoist drum?

340. What safety devices shall be installed on hoists to control speed and prevent cages being carried past the proper landings?

341. How should the overwinding device be shown to be in operating position?

342. What should be the minimum diameter of a rope used to hoist or lower men?

343. What safety device shall be installed on hoists to provide for positive stopping?

344. What safety devices shall be installed on cages used for hoisting men?

345. What shall be the maximum speed of a cage in a shaft or slope in which men are riding?

346. What safety device is required for a cage with an unstable self-dump platform used for hoisting or lowering men?

347. Who may ride on a loaded cage or car in any shaft, slope, or incline?

348. What control should be used to lower men in shafts or on slopes or inclines?

349. What provision should be made for passage of men from one side of a shaft to the other side?

350. What shall be the minimum dimensions of a travelway cut around the shaft?

351. How can a person working in the sump at the bottom of a shaft be protected?

352. How shall the top and bottom landings of a shaft be lighted?

353. If the outlets from a mine are shafts, what shall be provided for persons to escape from the mine in case of an accident?

354. In what condition shall stairs and hoisting machinery in shaft and slope mines be maintained?

355. How often should hoisting machinery used for emergency escape be tested?

356. What safety device shall be installed near the top and all intermediate landings of each slope or shaft?

357. What safety device should be used on trips going up a moderate slope?

358. What safety measure should be taken to guard against injury to men walking on a slope or incline?

359. What are the requirements as to the qualifications of persons placed in charge of hoist engines used for lowering or hoisting people?

360. In addition to devices for the free passage of sound, what other method of communication is required between the top and bottom of a working shaft?

361. What precaution shall an engineer, in charge of hoisting machinery, take to prevent misuse of the machinery?

362. What provision is made to protect the engineer or drum runner in the discharge of his duties?

363. When shall hoisting engineer be on duty within hearing of signals?

364. What are the requirements as to methods of communication between the top and bottom of a working shaft?

365. Is a hoisting engineer required for automatic cages?

366. Where should hoist signals be posted?

367. What should be the standard signal code for hoisting?

SAMPLE QUESTIONS FOR GENERAL MINING

1. What is the proper method of testing the mine roof?
    a. By sight, sound, and vibration when tapped with a solid instrument
    b. By using any object to sound the top
    c. By tapping the top with your hand
    d. By observing for sag
    e. None of the above

2. On belt conveyors that do not transport persons, stop and start controls should be installed at intervals not to exceed _____.
    a. 2,000 feet
    b. 500 feet
    c. 5,000 feet
    d. 1,000 feet
    e. None of the above

3. You are supervising a crew that is patching leaks in a seal located on the main mine return. You determine that the oxygen content is 18% where the miners are working. What should you do first?
    a. Nothing a level of 18% oxygen is allowed in the return
    b. Ventilate the area while the crew continues to work in the 18% oxygen area
    c. Remove the miners to air which contains at least 19.5% oxygen
    d. Warn the miners to be alert for "bad air"

4. In planning the layout of a mine, what governs the width of rooms and pillars?
    a. The number of tons required per day
    b. The height of the seam and the distance that a shuttle car has to travel to be loaded
    c. The extent of the liberation of gas and the amount of air available for ventilation
    d. The weight to be supported and the character of the roof, and coal bed
    e. None of the above

5. What type of material must conveyor belting be made of ?
    a. Flame resistant
    b. Fire proof
    c. Mildew proof
    d. Non-abrasive
    e. None of the above

6. Chemical extinguishers shall be examined every _____ months and the date of the examination shall be recorded on a permanent tag attached to the extinguisher.
    a. 1 month
    b. 3 months
    c. 12 months
    d. 4 months
    e. 6 months

7. Who is responsible for all of the underground workings in a mine?
    a. The Superintendent
    b. The Fire Boss
    c. The Assistant Foreman
    d. The General Mine Foreman
    e. None of the above

8. Why is multiple entry system more desirable than a double entry system?
    a. Haulage accidents are decreased
    b. Positive ventilation is more easily obtained and more escapeways are available in case of an emergency
    c. Haulage roads are more easily kept open
    d. Leakage of ventilation is reduced
    e. None of the above

9. How often must escapeways be examined in their entirety?
    a. Once a shift
    b. Once a week
    c. Once a month
    d. None of the above

10. What effect does the presence of small amounts of methane have upon the explosibility of coal dust?
    a. It decreases the explosibility
    b. It increases the explosibility
    c. It keeps it in suspension
    d. It has no effect
    e. None of the above

ANSWER SHEET FOR
COAL

1. It is the product of partial decomposition of vegetable matter without free access to air, and under the influence of moisture and pressure.
2. Moisture, fixed carbon, volatile matter and ash.
3. Fixed carbon and volatile matter.
4. Substances which are readily gasified by increased temperatures.
5. That portion of coal other than moisture which will not burn.
6. Sulphur and phosphorous.
7. It corrodes metal when burned, often causes clinkers, and affects the quality of iron, when coal containing sulphur is used
8. About 1.80
9. About 80 pounds
10. Approximately one thousand eight hundred (1,800) tons.
11. British Thermal Unit—The quantity of heat required to raise the temperature on (1) pound of water one degree (1^{o}) F. at sixty-two degrees (2^{o}).
12. By the number of B.T.U. per pound of coal.
13. The weight to be supported and the character of the roof, floor and coal bed.
14. The room and pillar system and longwall system.
15. A multiple entry system.
16. Positive ventilation is more easily obtained and the bad effects of falls are lessened.
17. Because coal is a valuable mineral and should not be wasted.
18. Because roof conditions may not permit the economical recovery of the pillars.
19. Pillars not pulled in proper sequence prevent good falls which relieve the weight on the pillars and extraction is made difficult and dangerous.
20. A system in which the coal is mined in panels, with barrier protection between panels.
21. It provides for better control of ventilation, increased safety, and guards against squeezes.
22. Effective ventilation may be difficult and squeezes or creeps may occur.
23. To obtain adequate falls and prevent excessive weight on the standing pillars.
24. To relieve the weight on the pillars and permit their safe and efficient extraction.
25. To protect from possible squeezes or creeps.
26. The action of excessive weight upon pillars not strong enough to support that weight.
27. The action of an excessive weight upon a weak floor or roof causing the floor to heave or the roof to sag.
28. By providing pillars of sufficient strength and by obtaining adequate falls by thorough and systematic mining.
29. By rapid extraction of pillars to obtain a break and by leaving pillars of sufficient strength to protect adjoining sections.
30. Bursting of coal caused by excessive pressure.

ANSWER SHEET FOR
GENERAL SAFETY

31. To insure the safety of persons employed within or at the mines and for the protection of mine property.
32. A safe travelway should be maintained from the interior of the mine to each of the surface outlets. Escapeways should be properly drained and kept free of all obstructions.
33. By signs, conspicuously placed throughout the mine.
34. In every mine where five (5) or more persons are employed in twenty-four (24) hours.
35. He shall be a citizen and resident of the state at the time he takes the examination.
36. Three (3) years
37. By passing an examination held by the Department of Mines.
38. A certified man.
39. The mine foreman.
40. At least once every week.
41. At least every week.
42. By at least one other person.
43. Methane Detector, Oxygen Detector, and Carbon Monoxide Detector.
44. Entrances to dangerous places shall be dangered off.
45. Such dangers should be removed promptly.
46. Every person whose safety is menaced shall be notified.
47. Necessary supplies.
48. He shall notify, in writing, the operator or superintendent of the mine and MSHA.
49. When official inspection is not provided.
50. To those authorized.
51. When accompanied by a certified official to assist in making the mine safe.
52. Only in case of necessity and in the performance of their duties.
53. They shall not be used as motive power.
54. Steam.
55. Intoxicating liquors.
56. Not nearer than five (5) feet from the dividing line.
57. When consent in writing has been obtained from every person interested.
58. When within fifty (50) feet of abandoned workings in such mine as shown by surveys made and certified by a competent engineer or surveyor, or within two hundred (200) feet of any other abandoned workings of such mine, which cannot be inspected.
59. To establish standard mine safety practices.
60. By preventing persons from performing acts, which are known to be hazardous.
61. Habits of observation are developed and hazards are more readily recognized.
62. They offer a medium for the exchange of ideas and experiences and provide means for a more thorough safety education.
63. Proper discipline is essential for the safe operation of a mine.
64. They shall be printed in the English language and posted in a conspicuous place about the mine.
65. Eighteen (18) years.
66. To instruct each person of the particular danger incident to his work and furnish a copy of the mining laws and company rules.
67. Under the direction of a mine foreman or a certified miner.

68. A system for checking men in and out of mines.
69. Serious consequences from infection may result from even trivial injuries.
70. Unchanged until an investigation is made by MSHA.
71. Safety hats and safety-toed shoes.
72. Goggles.
73. Serious injury may be caused to the eyes.
74. Safety belts.
75. It may become caught in moving machinery.
76. Safety belts.
77. Getting on or off in front of the equipment in motion.
78. They shall not permit other persons to remain near the machine.
79. When the cutter chain is in motion.
80. Locking devices.
81. Obstructions or lack of clearance may result in serious injury.
82. Clean and orderly.
83. In proper operating condition.
84. Unfamiliarity may result in injury.
85. Guards.
86. All guards or safety devices shall be replaced.
87. Signals should be given.
88. They should be securely blocked.
89. Limbs or clothing may become entangled.
90. Oil and Grease.
91. It shall immediately be removed from service until proper repairs are completed.
92. To see that it is open throughout its length as any obstruction may trap water, which may burst the pipe when heated.
93. Free from worn and broken strands and well lubricated.
94. In proper operating condition.
95. Flying burrs or uncontrolled action may cause serious injury.
96. The user
97. Oil, grease, and rubbish.
98. Guards or covers.
99. Handrailings, and toeboards where necessary.
100. Refuse and ice.
101. In good repair.
102. Open lights, smoking, and electricity.
103. Where danger of ignition of methane, oil grease, or coal dust is present.
104. At least once every two hours while the miners are at work.
105. Boreholes shall be kept not less than 20 feet in advance of the face and to the sides.
106. Two portable fire extinguishers and 240 pounds of rock dust.
107. A certified person shall check for gas with an approved detector before and during cutting or welding.
108. He shall remain until the place is made safe or dangered off and the men removed.
109. Escape facilities approved by MSHA.
110. It shall be removed to outby the last open breakthrough.
111. Each coal miner must be trained in the use of such and refresher courses given annually.

112.On the surface in close proximity to the mine entry. At dispatchers station, at the bottom of each regularly traveled shaft or slope, and at each working section not more than 500 feet outby the active working face or faces.
113.Person must be accompanied by one or more persons.
114.When striking rock or metal and when being transported in open type man trips.
115.Safety is the responsibility of the miners and the company.

ANSWER SHEET FOR BELTS AND CONVEYORS

116.At least 36 inches clearance.
117. (a)- 250 feet per minute when minimum overhead clearance is 18 inches.
(b)- 300 feet per minute when minimum overhead clearance is 24 inches.
118.When supplies are being transported.
119.At least six (6) feet apart.
120.At least 18 inches.
121.Not less than 24 inches.
122.A signaling system or method for stopping the belt.
123.Assistant mine foreman or some other person designated by the mine foreman.
124.Adequate and safe facilities.
125.(a)-Positive acting stop controls.
(b)-Adequate illumination at loading and unloading points.
(c)-Suitable communications where men load and unload.
126.Flame resistant.
127.At least every thousand (1,000) feet.
128.Deluge-type water sprays, water sprinklers, dry chemical sprinkler system or foam generators. (Designed to be automatically activated in the even of a fire or rise in the temperature at or near the belt drive).
129.Twenty four (24) inches of clear travelway on both sides of the belt.
130.(a) Following the last production shift each week.
(b) Before holidays, vacation periods and each production shift.
131.Inspection for frozen rollers, rock falls and fires.

ANSWER SHEET FOR HAULAGE

132.Haulage.
133.About twenty-five percent (25%).
134.Making flying switches, permitting men to ride on pushed trips, throwing switches and opening doors in front of moving trips, riding loaded cars, riding on the front bumpers of cars, laving unblocked cars on tracks, coupling cars in motion and getting off or on trips in motion.
135.Sufficient clearance should be maintained.
136.Not less than twenty-four (24) inches.
137.On the side of the entry opposite the wire (“safety side”)

138.Not less than twelve (12) inches.
139.Ample clearance shall be provided.
140.All supplies should be unloaded in a breakthrough or other opening where the clearance will not be obstructed, and on the side opposite to the trolley wire unless the wire is protected.
141.Twenty-four (24) inches
142.Shelter holes shall be provided and maintained.
143.One hundred (100) feet.
144.Five (5) feet in depth, four feet in width, and as high as the traveling space.
145.Clear of refuse and other obstruction
146.Level with the track.
147.At all times when men encounter approaching trips.
148.Look for the rear light, and for following traffic.
149.By a conspicuous light on both the front and rear.
150.The motorman and trip rider.
151.The mine foreman.
152.By a conspicuous light.
153.In proper operating condition.
154.In proper operating condition.
155.Sand
156.With shields.
157.Gongs or other sounding devices.
158.A lifting jack and handle.
159.He should operate at reasonable speed and keep trips under full control at all times.
160.In the deck.
161.By being pushed, except for switching.
162.At reduced speed and under full control, capable of immediate stop.
163.A system of signals methods or devices shall be used unless a dispatcher is employed.
164.A proper system of signals shall be provided.
165.Motorman should be within the deck and all persons and equipment in the clear.
166.One or more empty cars should be placed between the locomotive and the material.
167.Reverse levers should be on neutral and brakes set.
168.They should not damage, block, or permit ventilating doors to remain open.
169.No cars or other equipment should be spotted near or in doors or curtains.
170.He should report such places to the mine foreman immediately.
171.To see that all men are in the clear.
172.Under full control and at man trip speed.
173.At a safe speed not to exceed 12 miles per hour unless special covered man trip cars are used.
174.With precaution to the nearest turning point not to exceed eighty (80) feet or when going up extremely steep grades.
175.Obstructions or pole leaving the wire may cause the pole to break, resulting is serious injury.
176.So that no sharp projections exist, that cars are tight to prevent spillage, and that wheels are kept in proper running condition.
177.To the height of roof, timber, doors or trolley guards.
178.When other trips, which may get out of control are on the grade above them.
179.Mine Foreman or competent person.
180.By being pushed.
181.Drop-bottom cars unless special safety precautions are taken.
182.They shall not permit such riding.

183.No person.
184.On the trolley wire unless suitable covered man cars are used.
185.On the rear end of the trip.
186.From the wire side or the inside of a curve.
187.By coupling when not in motion.
188.By being marked.
189.Beyond the clearance points.
190.Under live electric wires after supervision has ceased.
191.That it is of proper size, well tied and spiked, joints well bolted, properly laid and kept clean and well drained.
192.All hazards connected with frequent derailments.
193.Insecure track, insufficient clearance and unsafe practices.
194.The track should be in safe and proper condition.
195.Because numerous accidents occur from derailment at working faces.
196.Clean and orderly.
197.The lurching of cars is lessened, derailments are decreased and transportation can be made safely at higher speed.
198.That they be full length.
199.On the side opposite the wire where possible.
200.Automatic or parallel throws.
201.With the main track (against working places).
202.Derails should be installed.
203.Stopblocks, chains or clevises.
204.That brakes are set and the cars are properly blocked.
205.By dividing the spread into the distance from the point to where the spread was measured.
206.Multiply the number of the frog by twice the gauge in feet (2gn.)
Example: If a track gauge is four (4) feet and the frog number is three (3) the lead should be 2 x 4 x 3 = 24 feet.
207.Multiply the square of the frog number by twice the gauge in feet ($2gn^2$).
Example: If a track gauge is four feet and the frog number is three what is the radius? 2 x 4 x 3^2 = 72 feet.
208.The distance between the rails, measured from ball to ball.
209.Shelter holes.
210.Warning lights or reflective signs or tapes shall be installed.
211.The locomotive operator shall have an assistant to assist him.
212.No person except the operator or his assistant.
213.In mines producing more than 1,000 tons of coal daily and coal is transported by rail haulage and there is movement of traffic underground including times when there is no coal in transit.
214.He is permitted to have no other duties.
215.On the surface after July 1, 1971.
216.All self propelled equipment.
217.No.
218.Tanks shall not be transported with such attached.
219.A certified foreman.
220.None.

ANSWER SHEET FOR TIMBERING

221.Falls of roof and coal.
222.About fifty (50%) percent.
223.A minimum and suitable roof support plan approved by MSHA.
224.By careful testing, inspection and systematic support.
225.He should thoroughly examine the roof and general conditions, and see that the necessary roof supports are provided to make the place safe.
226.The form of an arch.
227.The roof is often slaked and weakened by moisture.
228.That they are of proper length, straight grained, of sufficient sectional area and with ends sawed square.
229.The approximate length ordered or required.
230.Solid and sound throughout.
231.Promptly.
232.Sufficient props, caps, wedges, and cross-bars should be furnished where required.
233.He shall remain until the place is made safe or dangered off.
234.Before it has been made safe.
235.Frequent examinations should be made and safety posts should be set as required.
236.Proper roof support should be provided.
237.They shall be removed, carefully secured, or dangered off.
238.So that proper clearance is maintained.
239.Temporary posts should be placed to protect the worker.
240.Close to the face when necessary before other operations are begun and as needed thereafter.
241.Of soft wood.
242.It takes the first weight by crushing without affecting the strength of the prop.
243.It affords greater protection for the prop and in the case of a soft bottom it affords a greater bearing area.
244.Crossbars should be used.
245.A beam to support the roof, either hitched into the ribs or set on legs.
246.By setting on uneven surfaces, by having too small cap pieces, by not setting them vertically and by using inadequate or crooked timber.
247.With the top slightly up the pitch.
248.The person removing a post should be under well-secured roof.
249.In all cases where there is danger of overhanging roof.
250.By cutting or knocking.
251.Frequent falls of roof and coal.
252.By relieving the weight of the roof from the pillars, by obtaining adequate falls by straight pillar lines, by proper and systematic timbering, and by careful inspection and supervision.
253.By sound and vibration when tapped with a solid instrument.
254.One which conceals slips and kettle bottoms.
255.A large boulder with tapering edges, imbedded loosely in the roof.
256.A long slate bar.
257.A pick.
258.A method of supporting the roof by tying the roof strata together.
259.Roof bolts with expansion shells and bearing plates, or roof bolts and multipart resin.

260.An experimental area should be installed.
261.Additional bolts should be installed.
262.Confined to area specified in the approved plan.
263.At least the minimum length specified in the approved plan.
264.Diameter specified in the approved plan.
265.Anchored as specified in the approved plan.
266.Size of plate specified in the approved plan.
267.Not farther apart than specified in the approved plan.
268.The "twisting" force applied to the bolt.
269.As specified by the approved plan, usually from 125 to 175-foot-pounds.
270.Drawn tight by impact wrench or other approved methods.
271.By the use of a torque wrench.
272.The amount of tightening force applied between the bearing plate and the anchor.
273.By multiplying the torque reading by 40.
Example: 40 x 125 foot lbs. (torque) = 5000 pounds (tension).
274.The loss of torque after installation.
275.When the shell is anchored in soft rock such as shale, the high installation pressure causes the rock to yield and lets the bolt slip a small amount.
276. (a) Without approval of the MSHA.
(b) From complete pillared areas.
(c) From adjacent clay veins or hazardous places.
(d) Without the protection of temporary supports.
277.Periodically, at least every six months.
278.Designated MSHA representative.
279.At the mine, available to the miners and their representatives.

ANSWER SHEET FOR COAL DUST

280.Coal dust.
281.By being raised in clouds and ignited, the explosion is propagated through the mine.
282. When quantities of coal dust are raised in a sufficiently dense cloud in the presence of a source of ignition.
283. When the particles are suspended as a cloud in the presence of flame or spark.
284. Explosions of methane, electric arcs and explosives.
285. About eight hundredths (.08) or one-twelfth (1/12) of an ounce per cu. ft. of air.
286. Any particle of coal dust that will pass through a twenty (20) mesh screen.
287. None.
288. Fineness will increase the explosibility.
289. Yes. (Dampness causes the dust particles to cohere, and greater force is required to separate them and bring them into suspension. Once in suspension, if ignited, they will explode).
290. By the addition of incombustible material.
291. About twenty (20%) percent.
292. Accumulations of coal dust.
293. They shall be removed form the mine.
294. They should be thoroughly rock dusted.

295. The explosibility of coal dust and the danger of an explosion being propagated is reduced.
296. Dusts with a low free silica content.
297.A maximum of five per cent.
298.All will pass a twenty (20) mesh screen and not less than seventy (70%) percent will pass a two (200) hundred mesh screen.
299.In and beyond the last open breakthrough to within forty (40) feet of the face.
300.At least one (1%) percent for each one tenth (0.1%) percent of methane.
301.Water, calcium chloride or other dust allaying materials should be applied.
302.By sprinkling or other dust allaying materials should be applied.
303.MSHA.
304.Men exposed for short periods to gas, dust, fumes and mist.
305.They shall be kept free from excessive accumulations of coal dust.
306.By collecting samples of dust from the sides, roof and floor and analyzing them for total incombustible content with a device known as a "volumeter", or by proximate analysis.
307.It increases the explosibility.
308.Increase in volatile matter tends to increase its explosibility.
309.All operating sections, haulageways and parallel entries connected there by open crosscuts and return entries.
310.Not less than sixty-five (65%) percent but in return entries not less than eighty (80%) percent.

ANSWER SHEET FOR DRAINAGE

311.The water should be kept free from pollution.
312.He shall have all water drained or hauled out of working places where practicable.
313.They should be properly drained and free from obstruction.
314.Air courses may be blocked so as to interfere with ventilation.
315.Transportation is usually handicapped; it is difficult to maintain track as ballast washes out; it is difficult to keep rolling stock properly lubricated; rails and fittings become corroded; production is limited; and the filling of swags may interfere with ventilation.
316.By ditching, by siphon lines and by pumping, and insofar as possible, by keeping water from entering.
317.Sixty-two and five-tenths (62.5) pounds.
318.0.434 pounds.
319.Seven and five-tenths (7.5) gallons.
320.Eight and one third (8.33) pounds
321.Thirty-four (34) feet.
322.About twenty-two (22) feet.
323.It is a pipe line bent downwards at some point to form two legs, the shorter of which is for suction and the longer for discharge.
324.That it have no air leaks; that the outlet is lower than the inlet; that each leg be laid on a uniform gradient so that air pockets will not form.
325.Water is raised over a summit by atmospheric pressure when the line is full of water and flows from the discharge leg by gravity.
326.The reciprocating pump and the centrifugal pump.
327.The reciprocating pump.

328. The resistance of the static head of the weight of the water to be pumped and the resistance of the pipe to the flow of water.
329. The resistance of the static head or the weight of the water to be pumped and the resistance of the pipe to the flow of water.
330. 671 feet. (Solution: 610 x 110%=671 feet).
331. 34.84 H.P. (Solution: H.P. = $\frac{400 \times 345 \times 8.33}{33{,}000}$ = 34.84 H.P.)
332. 200 minutes. (Solution: GPM= $\frac{33{,}000 \times 40}{360 \times 8.33}$ = 440 gallons per minute $\frac{88{,}000}{440}$ = 200 minutes.)

ANSWER SHEET FOR SHAFTS AND SLOPES

333. A safe operating condition.
334. A safe operating condition.
335. Each twenty-four (24) hours by a qualified electrician.
336. At least once every six (6) months.
337. At least once in each twenty-four (24) hours.
338. At lest once each month.
339. Three or more.
340. Overwind and overspeed devices and an emergency safety stop.
341. By a green signal light in the hoist room and at all landings.
342. Three-quarters (3/4) of an inch.
343. Each hoist should have an adequate brake.
344. Approved safety catch, bridle chain, automatic stopping device or automatic overwind and a sufficient cover overhead, adequate brake on the drum and approved safety gate at top of the shaft.
345. One thousand (1,000) feet per minute.
346. A locking device.
347. No one, except an authorized trip rider in the performance of his duties.
348. Power control.
349. A bypass should be constructed around the shaft.
350. Five (5) feet high and three feet wide.
351. By fixing the safety dogs to prevent the cage form descending.
352. With sufficient stationary lights.
353. The shaft shall have either stairs or hoisting machinery.
354. In a safe and usable condition.
355. At least once each month.
356. A positive action safety block or derailer.
357. A trailing derailer, or drag.
358. No person should be permitted to walk the slope or incline while trips are in motion.
359. They shall be competent and sober.
360. A standard means of signaling.
361. Permit no interference with any part of the machinery.
362. Interference or intimidation is prohibited.

363.When men are in shaft mines.
364.A metal tube, telephone, or other approved means of communication shall be provided.
365.No.
366.At shaft landings and in front of hoisting engineers.
367. 1 Signal--Hoist
1 Signal--Stop
2 Signals—Main Cage
1 Signal from hoisting engineer--Men Board Cage.

ANSWER SHEET FOR GENERAL MINING

1.	a	6.	e
2.	d	7.	a
3.	c	8.	b
4.	d	9.	b
5.	a	10.	b

CHAPTER FOUR

RECORDS

1. Permits and Approvals
2. Notifications
3. Findings, Notices, and Orders
4. Mine records
5. Mine Maps

RECORDS
PERMITS AND APPROVALS

1. What permit is required relative to the operation of fans?
2. What approval is required relative to the hoisting of men?
3. What permit is required to shoot coal?
4. What permit is required relative to the number of shots to be fired at a time?
5. What permit is required relative to delay detonators?
6. What permit is required relative to the use of steam boilers?
7. From what department is a permit obtained to operate steam boilers?
8. What permit is required to remove coal near an oil or gas well?
9. What permit is required relative to non-permissible blasting devices?
10. What approval is required relative to second openings?
11. What approval is required relative to new or additional ventilating openings?
12. What approval is necessary to open or reopen a mine?
13. When must the operator apply for an extension of the approval to open a mine?
14. What approval is required relative to the roof conditions and mining system of each coal mine?
15. What approval is necessary relative to roof bolt recovery?
16. What permit is required to move energized power centers and transformers?
17. What approval is required of escape facilities at each shaft or slope?
18. What approval is required for self-rescue devices for miners in case of emergency?
19. What is required to work electric equipment in return airways?
20. What approval is required when abandoned workings are sealed?

NOTIFICATIONS

21. In the event of an explosion, death, or serious personal injury, who must be notified?

22. When must MSHA be notified of an explosion; death or serious personal injury?

23. When must a written report be sent to MSHA.

24. How soon must a written report be furnished to MSHA in the case of injury or death in or about a coal mine?

25. Who must be notified in the event of a fire in or about any mine?

26. How soon must MSHA be notified in case of a mine fire?

27. Who must be notified before coal is removed within three hundred (300) feet of an oil or gas well?

28. What is the duty of a representative of MSHA at the commencement of any inspection of a coal mine?

29. What information is required by each mine operator relative to the principal officer in charge of the health and safety program at each mine?

30. Who must be notified before sealed areas, temporary or permanent, are reopened?

FINDINGS, NOTICES, AND ORDERS

31. When a mine inspector finds that by reason of any dangerous condition or unsafe practices the lives or health of persons are endangered, what actions shall be taken?

32. How is the mine inspector required to notify the operator or agent of dangerous conditions or unsafe practices?

33. What is the duty of the operator, agent, superintendent or mine foreman relative to written instructions issued by the mine inspector?

34. What shall a mine inspector do upon making an inspection of a mine and finds danger or before the imminence of such danger can be eliminated?

35. What shall a mine inspector do upon making an inspection ands finds that any provision of the mine law is being violated but that the conditions created do not cause such danger that an accident will occur immediately or before such danger can be eliminated?

36. What shall a mine inspector do upon remaking an examination after having issued notice (citation)?

37. What shall a mine inspector do upon remaking an examination after having issued an order or citation and finds the condition corrected?

38. If any violation has not been totally abated, and the reasonable time has expired, what shall the mine inspector do?

39. When a mine is closed as being unsafe, what action is permitted the owner or operator?

40. What is the duty of the MSHA mine inspector in the event of an explosion or accident resulting in death?

41. What is the duty of the mine inspector when at the scene of an explosion or accident?

42. Besides rendering assistance at the scene of an explosion or accident, what is the mine inspector required to do?

MINE RECORDS

43. What record of ventilation should be kept?

44. How must the record of air measurements be kept?

45. What daily report must the mine foreman or his assistants keep?

46. What record of the examination of air courses, roads and openings that give access to old workings or falls must the mine foreman or his assistants keep?

47. How shall records of all dangerous conditions be kept?

48. What daily report should be kept by the fire boss?

49. What is the duty of the foreman relative to the daily report of the fire boss?

50. Who is permitted to inspect the daily reports of foreman, assistants, and fire bosses?

51. What should be repeated on the daily report?

52. What record of man hoists should be kept?

53. What record relative to fans must be kept?

54. Where must the certificate of the inspection of a mine be posted?

55. How long should the certificate of inspection remain posted?

56. What certificate of training is required of all inside employees before he is a certified miner?

57. What certificate of training should be held by all mine employees?

58. What certificates of training should be held by all mine officials?

59. Where should the record of Mine Foreman's certificates be kept?

60. Who shall keep copies of the record of the examinations of persons for competency in the use of approved methane detectors?

61. What record of annual physical examinations shall be kept on file by the operator and a copy furnished to MSHA?

62. What daily records relative to belt conveyors must be kept?

63. What record of electric equipment should be kept?

64. What record must be kept relative to power centers and transformers?

65. What record shall be kept of oxygen and gas tanks or cylinders taken into a mine?

MINE MAPS
PREPARING THE MAP --- MAP SYMBOLS

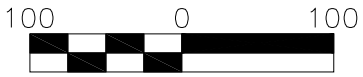
The first step in reading any type of map is an understanding of the symbols used to depict its features. When reading a road map many of the symbols are familiar and do not require any additional interpretation on the part of the user. This knowledge has been gained through experience aided by the availability of road maps for public use. Mine maps are no different. Once an understanding of the symbols is attained, the map can be read and understood. Although many mine map symbols are standardized, some are not. It is important that a legend be placed on the map to illustrate the meaning of each symbol. The reader must consult the legend to understand the map.

SCALE

The mine map must have a scale to indicate the distances. The scale tells the reader the distance that one inch on the map represents. The scale may look like this:

SCALE 1" = 100'

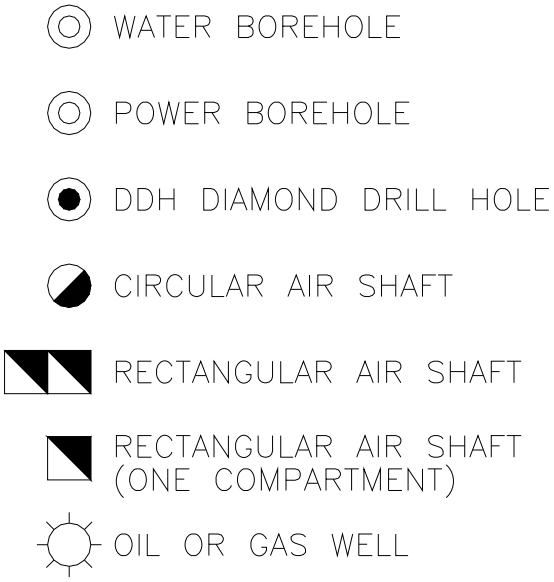
or this:



Both above scales indicate that one inch on the mine map represents 100 feet in the mine, and the lower scale indicates that one small block represents 25 feet.

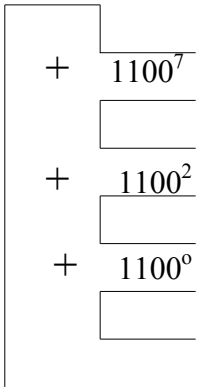
BOREHOLES

A borehole is a hole connecting the surface with the underground workings of a mine. the hole may be as small as 2 inches in diameter for a diamond drill hole or as large as 30 feet for an airshaft.



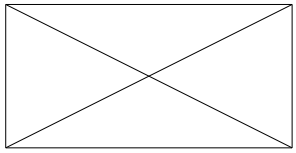
ELEVATION

Mine floors are not level. There are high and low places in a mine. The elevations represent the distances in feet from sea level to the mine floor. On the mine map elevations look like this:

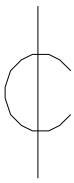


VENTILATION CONTROL SYMBOLS

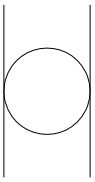
Fan - A mechanical device powered by an electrically driven motor or by an internal combustion engine to pull or push air through the mine workings.



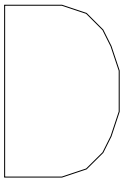
Check Curtain - A partition made of incombustible material, such as plastic or canvas, used to deflect or direct air to the working place. It is construction in a manner to allow the passage of men and machinery.



Box Check - A stopping with an opening in it to allow a conveyor to pass through used to prevent intake or return air from flowing across the conveyor.

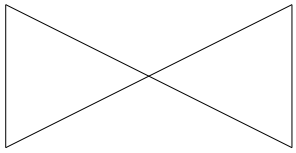


Door - A large hinged door completely closing a mine entry. Doors are usually installed in pairs to form an air lock, allowing haulage equipment to pass through one door at a time without allowing air to flow.

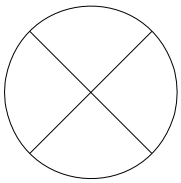


Line brattice - A partition made of incombustible material used to direct air to the working face, which is usually installed within ten (10) feet of the face.

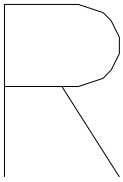
Overcast - An enclosure built in an intersection of mine passages which allows two air currents to cross without mixing. One air current crosses the other above the coal seam, or in some instances through pipes.



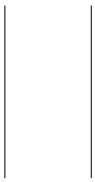
Undercast - Similar to an overcast except that one air current crosses under the other below the coal seam.



Regulator - An adjustable door or opening in a stopping generally placed across a return airway, and used to adjust the amount of air passing through the airway in order to properly distribute airflow.



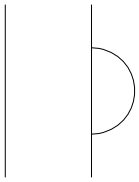
Stopping (permanent) - A solid incombustible substantial wall built across a mine passage to separate intake air from return air, to direct air through the mine, to form escapeways, and to isolate belt conveyor entries.



Stopping (temporary) - A stopping built of less substantial material than permanent ones which is used in places where the ventilation will be changed and generally replaced by permanent stoppings.

Seal - A stopping built of greater thickness and more substantial construction used to isolate abandoned areas of a mine from the active workings.

Mandoor - A door installed in a permanent stopping to allow persons to travel from one entry to another which must be constructed to prevent air from leaking through the stopping when the door is closed.



MAPS

66. Who is required to furnish maps of coal mines?

67. What must be the scale of maps of coal mines?

68. Who must certify the map of a coal mine?

69. What map is required to be kept at the mine?

70. How is the ventilation to be shown on the map?

71. How may the effectiveness of the ventilating current be shown on the map?

72. What is the penalty for making an incorrect map or a false statement in connection therewith?

73. What is required of a mine operator before coal is removed from within less than three hundred (300) feet of a gas or oil well, or before workings are extended beneath any tract of land on which oil or gas wells are drilled or proposed to be drilled?

74. After filing with a well operator and MSHA the required maps showing an intention to mine in the vicinity of an oil or gas well, how close to the well may the mine operator remove coal?

75. When may the mine operator remove coal from within less than three hundred (300) feet from the oil or gas well?

76. What procedure is necessary before a mine operator may obtain approval to mine from within less than three hundred (300) feet of an oil or gas well?

77. How often must maps showing the progress of mine workings within three hundred (300) feet of oil or gas wells be extended?

78. To whom must be sent every six (6) months a copy of the map showing the progress of mine workings within three hundred (300) feet of oil or gas wells?

79. How often must the map of the coal mine be updated?

80. To whom must a copy of the map of a coal mine be delivered semi-annually?

ANSWER SHEET FOR RECORDS PERMITS AND APPROVALS

1. Ventilation and fan stoppage plan approved by MSHA.
2. When hoisting more than twenty (20) persons at a time.
3. To shoot coal from the solid.
4. To fire more than one shot at a time (multiple shooting).
5. To use regular (1/10 second) or millisecond (1/1000) delay detonators.
6. To operate boilers carrying more than 15 pounds per square inch (psi) of stream pressure.
7. Utah Labor Commission.
8. To remove coal within three hundred (300) feet of an oil or gas well.
9. A permit to have, use, or store them in or about the premises of any mine.
10. Approval to work a limited number of men, twenty (20) or less, when there is no second outlet.
11. Approval for the plan of the proposed ventilation and ventilating equipment, with their location and relative position to adjacent developments.
12. Approval of Utah Division of Oil, Gas, and Mining (DOGM).
13. When major changes to the mine plan occur.
14. A roof control plan and revisions thereof suitable to the roof conditions and mining system of each mine shall be approved by MSHA.
15. It shall be conducted only in accordance with methods in the approved roof control plan.
16. When other power source is not available, the MSHA may permit such centers and transformers to be moved while energized if adequately protected from hazard to the miners.
17. Approval of MSHA.
18. The self-rescue device shall be approved by MSHA.
19. Equipment must be approved by MSHA and maintained in permissible condition.
20. That such sealing is done with incombustible material in a manner prescribed by MSHA.

ANSWER SHEET FOR NOTIFICATIONS

21. MSHA.
22. Immediately.
23. When an accident in or about any coal mine results in injury or death.
24. Within twenty-four (24) hours.
25. MSHA.
26. Immediately.
27. MSHA and the well operator.
28. To notify and give the representative of the miners at the mine an opportunity to accompany him on such inspection.
29. Such person’s name and address shall be filed with MSHA and Utah Labor Commission.
30. MSHA.

ANSWER SHEET FOR FINDINGS, NOTICES, AND ORDERS

31. He shall immediately notify the operator or his agent.
32. In writing.
33. To not permit any person to work in violation of such instructions.
34. He shall immediately issue an order, requiring the operator to cause all persons to be withdrawn from the area except those persons necessary to eliminate the danger.
35. He shall issue a notice (citation), stating the violation and giving a reasonable time for the operator to eliminate the violation.
36. If necessary corrective action has been completed, he shall issue abatement notice. If work has not been completed and he finds cause to extend the time to abate the violation, such notice will be issued. An order could be issued if an extension is not warranted.
37. He shall issue a notice, citing the abatement of the order.
38. Withdraw all persons from the affected area except those necessary to correct the danger.
39. He may apply to the MSHA District Manager for a special inspection or review. Recourse is then open to have the case taken before the courts.
40. He must immediately go to the scene of such accident.
41. To render such assistance as he may deem necessary for the future safety of the men.
42. Make an investigation of the cause.

ANSWER SHEET FOR MINE RECORDS

43. A weekly record of the air measurements required by CFR 75.364 must be retained at a surface location for at least 1 year.
44. In a secure book or electronic format acceptable to MSHA.
45. A record of any dangerous conditions or practices found at each working place in the mine.
46. A weekly record of the condition of all places where danger has been found.
47. Recorded in ink or indelible pencil in a book provided for the purpose, or in an acceptable electronic format.
48. A written record of his examination.
49. He should carefully read and countersign the daily report of the fire boss.
50. All interested persons.
51. Unsatisfactory conditions and practices previously reported but not corrected.
52. A daily record of inspection.
53. A daily record of the inspection of the main fan or by adequate facilities provided to permanently record the performance of the fan and to give warning of an interruption.
54. At a prominent place, near the mine.
55. Until replaced by a subsequent certificate.
56. A mine safety course and first aid.
57. A first-aid certificate.
58. First-aid and annual retraining.
59. At the mine.

60. The operator and MSHA.
61. Members of a rescue team employed at each mine.
62. Frozen rollers, rock falls and fires.
63. Required weekly examinations.
64. When energized power centers and transformers are examined prior to movement.
65. The date shall be recorded when they are taken into a mine and when they are removed from the mine.

ANSWER SHEET FOR MINE MAPS

66. The operator.
67. Not less than one hundred feet to the inch, and not more than five hundred feet to the inch.
68. A registered engineer or licensed land surveyor.
69. A map of the mine.
70. By arrows.
71. By showing the volume of air passing the last breakthrough of each entry.
72. A fine of not less than five hundred (500) nor more than one thousand ($1,000) dollars.
73. The operator should forward maps to the well operator and MSHA showing the mine workings and projected mine workings beneath any tract of land on which oil or gas wells have been drilled or proposed to be drilled and within three hundred feet of such wells.
74. Not nearer than three hundred (300) feet from the oil or gas well.
75. When consent is obtained from MSHA.
76. The operator should file an application and petition with MSHA and the well operator, together with a map showing the size of the pillars to be left around the well and the proposed plan of mining within less than three hundred (300) feet of the well.
77. Once every six (6) months.
78. MSHA.
79. At intervals of not more than 6 months.
80. MSHA.

CHAPTER FIVE

EXPLOSIVES

1. Permissible Explosives
2. The Use Of Explosives
3. Firing Devices
4. Blasting & Explosives

EXPLOSIVES
PERMISSIBLE EXPLOSIVES

1. What is a permissible explosive?

2. For what purpose are permissible explosives designed?

3. What is the principal ingredient in a permissible explosive generally used for shooting coal?

4. What agency passes upon the permissibility of an explosive?

5. What are the characteristics of the flame which determines the permissibility of an explosion?

6. What maximum volume of poisonous gases determines the permissibility of an explosive?

7. What class of permissible explosives liberates the smallest volume of poisonous gases?

8. Beside the characteristics of their ingredients, what other conditions determine the permissibility of an explosive?

9. To remain permissible, what must be the physical condition of a permissible explosive?

10. How may permissible explosives become deteriorated?

11. To remain permissible, how must a permissible explosive be fired?

12. To remain permissible, what kind of a blasting unit must be used to fire permissible explosives?

13. To remain permissible, what is the maximum charge of permissible explosives for one hole six (6) feet or less in depth?

14. To remain permissible, what is the maximum charge of permissible, explosives for one hole six (6) feet or more in depth?

15. To remain permissible, how must permissible explosives be stemmed?

16. What may be the result of using permissible explosives in a non-permissible manner?

17. What is the effect of dampness upon permissible explosives?

18. What is the factor of safety of permissible explosives over black blasting powder?

19. What is the factor of safety of permissible explosives over dynamite?

20. Has an increased use of permissible explosives been followed by a decreased number of explosive accidents?

21. What is the principal cause of explosive accidents when permissible explosives are used?

22. What poisonous gases are liberated by explosives?

23. What are the dangers from burning explosives?

THE USE OF EXPLOSIVES

24. What quantity of explosives is a hand loader permitted to take into a mine?

25. What quantity of explosives may be stored underground in magazines?

26. How shall explosives be carried into a mine?

27. How may explosives be hauled by electrically operated trips?

28. What should be the provisions relative to carrying explosives on trips, which carry workmen?

29. How close to a man trip may a powder trip be operated?

30. In what direction should the air travel relative to a man trip and a powder trip?

31. How shall explosives and firing devices be kept with respect to each other underground?

32. What is the minimum distance from a roadway or power wire that underground powder magazines may be placed?

33. How should explosives be stored near the face?

34. How far from the face must powder boxes or magazines be kept from the face?

35. In what manner should explosives and blasting caps be kept in a mine?

36. Where should explosives and blasting caps not be kept?

37. In what manner should explosives and blasting caps be disposed of at the end of a shift?

38. What type of shot shall not be fired in any mine?

39. What is the danger of adobe or mud-capping?

40. How should heavy boulders be blasted?

41. What is the only kind of explosive that can be used in a coal mine?

42. What is the purpose of cutting the coal?
43. What is the danger of shooting off the solid?
44. What shall be the length of the drill hole?
45. What is the effect of too long a hole or one which grips the rib?
46. How shall the hole be prepared before loading?
47. How many kinds of explosives may be used in the same hole?
48. How shall explosives be confined in a drill hole?
49. What is proper stemming material?
50. Why is coal dust stemming dangerous?
51. What is the effect of incombustible stemming upon the flame of an explosion?
52. What are the practical benefits of proper stemming?
53. What is the danger of improper stemming?
54. What kind of a stemming tool should be used?
55. What should be the maximum length of a metal scraper attached to wooden tamping?
56. What kind of stemming tools should be prohibited?
57. What may be the danger of an undercharged hole?
58. What may be the result of the charge being separated by unremoved drillings?
59. May electrical equipment be operated in the face area while bore holes are being charged?
60. How soon after charging shall holes be fired?
61. What may be the cause of a premature shot?
62. What creates the force when an explosive is fired?
63. In what direction is the maximum force of the explosive exerted?
64. Who must be warned before shots are fired?
65. How should warnings be given when shots are about to be fired?

66. What should persons do when warned that shots are to be fired?

67. Where should persons be when shots are fired?

68. When should the shot firer make the connection to the shooting cable?

69. How soon may a person approach the face after a shot has been fired?

70. What shall be done after shooting before work is resumed?

71. What is the first thing to do when a misfire has occurred?

72. In the even of a misfire how should the place be guarded against injury to others?

73. How long shall any person wait after a misfire before going back into the place?

74. How shall a misfire be removed?

75. Who shall supervise the removal of a misfire?

76. What method of removing misfires should not be permitted?

77. How can misfires be prevented?

78. What precaution should be taken to guard against misfires when multiple shooting is done?

79. Who shall be designated to fire shots?

80. What are the qualifications for a shot firer?

81. How shall explosives be stored?

82. What distance shall powder magazines be located away from mine openings, occupied buildings, or public roads?

83. With what material shall the outside of powder magazines be constructed?

84. What accumulations shall not be permitted in or around magazines?

85. What should be the qualifications of persons designated to distribute explosives?

86. What methods of lighting shall not be permitted in magazines?

87. What shall be posted near magazines?

88. What type of tools should be used to open cases of explosives?

FIRING DEVICES

89. Should fuse and squibs be used in coal mines?

90. How is an electric blasting cap protected from stray currents?

91. How is a shunt made?

92. When should a shunt on leg wires be removed?

93. What is the proper type of shot-firing cable?

94. What precautions should be observed when unwinding the shot-firing cable?

95. Who should connect and handle the shooting cable?

96. How should the shot-firing cable be handled between the charge and the firing station?

97. What shall be the minimum length of a shot-firing cable?

98. What should be the requirement of shooting cables relative to strength?

99. How should shooting cables be maintained?

100. How may shooting cables be protected from stray currents?

101. What determines the permissibility of a blasting unit?

102. Why should shots not be fired from the trolley wire?

103. What is the greatest danger from electric firing?

104. When should the blasting cap be placed in explosives?

105. Where should the blasting cap be placed when a bore hole is charged?

106. What is the primer used to fire a charged hole?

107. How should the blasting cap be inserted in a primer?

108. May 1/10 second delay detonators be used underground?

109. May 1/10 second delay detonators be used to shoot coal?

110. What are the requirements relative to ventilation when using multiple shooting in the bottom or top?

111. May (1/1000) millisecond delay detonators be used for blasting coal?

112. How must the shot-firing circuit be tested when using millisecond (1/1000) delay detonators?

113. How must the leg wires be connected when using millisecond delay detonators?

114. May instantaneous, regular, or zero-delay detonators be fired in the same circuit as millisecond delay detonators?

115. What is the maximum and minimum delay interval between adjacent rows of shots, when using millisecond delay detonators?

116. What is the maximum time delay in an entire round of shots when using millisecond delay detonator?

117. What must be done before a misfire is removed when using millisecond delay detonator?

SAMPLE QUESTIONS FOR BLASTING AND EXPLOSIVES

1. The danger presented by shooting on the solid is _____.
    a. The danger of premature explosions
    b. The danger of misfires
    c. The possible ignition of gas and coal dust by blown out shots
    d. The production of an excessive amount of coal dust

2. The Secretary may, under such safeguards as he may prescribe, permit the firing of more than the maximum legal limit on the number of shots and allow the use of non-permissible explosives in _____.
    a. Sinking coal transfer shafts in rock
    b. Removing bottom to establish track grade
    c. Sinking shafts and slopes from the surface in rock
    d. Driving rock tunnels through faulted areas

3. All completed shots shall be fired _____.
    e. Within 5 minutes
    f. Within 10 minutes
    g. Within 15 minutes
    h. Promptly
    i. Before the shift ends

4. Before priming any explosives all mobile electric equipment shall be removed to a distance of at least _____ feet from the working place or other area where blasting is to be performed.
    a. 50
    b. 100
    c. 500
    d. 1,000
    e. None of the above

5. When blasting off the solid in bituminous and lignite mines, only pliable _____ dummies shall be used for stemming.
    a. Any non-combustible material
    b. Rock dust
    c. Water
    d. Clay
    e. None of the above

6. The total weight of explosives loaded in a borehole less than 6 feet deep in bituminous and lignite mines shall be reduced by _____ pounds for each foot of borehole less than 6 feet.
    a. 1
    b. 1/2
    c. 2
    d. 2 1/2
    e. None of the above

7. Each borehole in coal for explosives shall be at least _____ inches from any other borehole in rock.
    a. 12 inches
    b. 36 inches
    c. 26 inches
    d. 24 inches
    e. None of the above

8. Explosives and detonators shall be kept in separate containers until _____.
    a. They are transported into the mine
    b. They are to be transported to the job
    c. They are to be stored
    d. They are to be used, i.e. immediately before blasting

9. What is the effect of dampness on explosives?
    a. None
    b. Damp explosives exert more force during the explosion
    c. Damp explosives deteriorate rapidly
    d. Damp explosives will not fire

10. Is it permissible to combine detonators made by different manufacturers in the same blasting circuit?
    a. Yes, as long as they are of the permissible type
    b. It is permissible as long as only certified people do the blasting
    c. Mixed brands of detonators shall not be combined in the same blasting circuit
    d. Yes, as long as written approval is acquired from the Mine Manager

ANSWER SHEET FOR EXPLOSIVES
PERMISSIBLE EXPLOSIVES

1. One which has passed certain tests conducted by the Bureau of Mines.
2. For safe use in mines.
3. Ammonium nitrate.
4. The U.S. Bureau of Mines
5. Short flame of short duration.
6. The poisonous gases should not be greater than five and one-half (5 1/2) cubic feet per one and one half (1 1/2) pound charge.
7. Class A.
8. The conditions under which they are used.
9. It must be in first class condition when used.
10. By moisture, improper storage, or age.
11. By electric detonators of proper strength.
12. A permissible blasting unit.
13. One and one half (1 1/2) pounds.
14. Three (3) pounds.
15. The coal must be cut of sheared unless written permission is granted by the Department of Mines to shoot on "solid".
16. Any of the accidents which may occur from the use of other explosives.
17. They deteriorate rapidly.
18. At least forty-five (45).
19. At least seventeen (17).
20. Yes, decidedly so.
21. Carelessness or improper usage.
22. Carbon monoxide and oxides of nitrogen.
23. Fires, explosions, and dangerous gases.

ANSWER SHEET FOR
THE USE OF EXPLOSIVES

24. No greater quantity than he may reasonably expect to use in any one shift.
25. No more than a 48 hour supply.
26. They shall be carried separately from firing devices and enclosed in non-conducting boxes.
27. In substantially covered cars lined with non-conductive material or in special substantially built covered containers lined with non-conductive material.
28. Explosives should be prohibited from trips which carry workmen.
29. No less than five (5) minutes apart.
30. From the man trip towards the powder trip.
31. They shall be kept in separate containers at least five (5) feet apart or in the same container separated by a 4 inch hardwood partition.
32. Fifteen (15) feet.
33. In a dry place free from the danger of stray electric currents or flying objects.
34. At least one hundred (100) feet from the faces and out of direct line of blasting.
35. Open for inspection at all times.

36. Buried in the gob.
37. In accordance with an established system for the mine.
38. Adobe or mud-capping or any other unconfined shot.
39. The unconfined explosion will raise dust which may become ignited.
40. By blockholding. A hole is drilled and the explosive is confined with stemming and a pile of incombustible material placed over the hole.
41. Permissible explosives or other permissible blasting devices.
42. To provide an additional free face or faces to assist the action of the explosive and lessen the danger of a blow-out shot.
43. Ignition of gas and coal dust by blown-out shots.
44. Not deeper than the depth of cut.
45. The effect of the cut is partially lost and a blown-out shot may be caused.
46. It shall be scraped clean as far as practicable.
47. One (1) only.
48. They shall be confined with incombustible material.
49. Incombustible material such as sand, clay, rockdust, or special devices such as water dummies.
50. The flame of the explosion will be increased and the coal dust may be ignited.
51. The length and duration of the flame are decreased.
52. The shot is more effective.
53. The danger of a blown-out shot.
54. A wooden tamping stick.
55. Eight (8) inches.
56. Metal or metal-clad tamping bars.
57. The charge may not be sufficient to break the coal and may result in a blown-out shot.
58. Incomplete explosion and possible burning of the unexploded charge.
59. No.
60. Promptly.
61. Stray currents.
62. The sudden expansion of the gases liberated.
63. Equally in all directions, but it takes the direction of the least resistance.
64. Others in the place and in places about to be cut into.
65. By shouting “Fire” three times slowly after those notified have withdrawn.
66. Withdraw immediately.
67. Out of the line of fire around a corner.
68. When other persons are out of the line of fire.
69. Not until the smoke has cleared away.
70. The roof shall be examined and the place made safe.
71. Disconnect from the blasting unit and short-circuit the wires by twisting them together.
72. The miner should remain on guard at a safe distance until a foreman arrives.
73. Five (5) minutes.
74. Another hole may be drilled at least twenty four (24) inches away and fired or by washing the stemming and charge from the bore hole with water, or by inserting and firing a new primer after the stemming has been washed out.
75. A foreman or competent person.
76. By drilling them out.
77. By a careful selection of the explosives and firing device and correct loading and firing of the charge.
78. A careful examination should be made for misfires after each shot.

79. Only persons who can qualify as competent shot firers.
80. (1) Two years practical experience in coal mines.
    (2) A knowledge of ventilation, mine roof and timbering.
    (3) Certification by the Department of Mines.
81. In cool, dry, well ventilated magazines.
82. Two hundred (200) feet unless barricaded.
83. With incombustible material.
84. Rubbish or combustible material within twenty-five (25) feet of the magazines.
85. They should be competent.
86. Open lights.
87. Warning signs placed so that a bullet going directly through them will not hit the magazine.
88. Wooden tools.

ANSWER SHEET FOR FIRING DEVICES

89. No
90. By means of a shunt.
91. It is made by short-circuiting the end of the leg wires.
92. Not until connection has been made with the shot-firing cable.
93. A rubber covered two-conductor cable of adequate size and length.
94. Care should be taken to keep it from contacting rail, wire, pipe, or bottom, which may carry stray electric currents.
95. The person who fires the shot.
96. It should be unreeled from the charge toward the “firing station”.
97. One hundred (100) feet. (Should be purchased 125 (125) feet long).
98. They should be mechanically strong to prevent excessive stretching.
99. Free from cuts and abrasions.
100. By being shunted.
101. The current is not strong enough to ignite gas and it is provided with a safety contact.
102. High voltages may form arcs, which will ignite gas or coal dust.
103. Current may be applied before the men have reached a safe place or stray currents may cause a premature explosion.
104. Not until the holes are ready to be charged.
105. It should be placed centrally in the primer and pointed toward the body of the charge.
106. A cartridge with the blasting cap inserted.
107. By inserting it full length into the end so that the loaded end is on the axial line.
108. Yes, with written permission from the Director of the Department of Mines.
109. No, but they may be used for grading above and below coal seams.
110. It must be done on intake air except by permission from the Director of the Department of Mines.
111. Yes, with written permission from the Director of the Department of Mines.
112. With a galvanometer.
113. In series.
114. No.
115. Not more than one hundred (100) nor less than twenty-five (25) millisecond.
116. Not more than five hundred (500) milliseconds.
117. Test the failed shot with a galvanometer.

ANSWER SHEET FOR
BLASTING AND EXPLOSIVES

1.	c	6.	b
2.	b	7.	d
3.	d	8.	d
4.	a	9.	a
5.	d	10.	c

CHAPTER SIX

ELECTRICITY

1. Basic Electricity
2. Fire Protection

BASIC ELECTRICITY

1. What is the unit of electric pressure?
2. What is the unit of flow per second of an electric current? (what is current?)
3. What instrument is used to measure amperes?
4. What instrument is used to measure voltage?
5. What is the unit of electrical power?
6. What instrument is used to measure watt-hours?
7. What is the unit of resistance to the flow of electrical current?
8. What instrument is used to measure resistance?
9. What is the formula to find the flow of current in a direct current motor?
10. What is the formula to find the voltage in a direct current circuit?
11. What is the formula to find power consumed by a direct current motor?
12. How many watts are equal to one horsepower?
13. What is a kilowatt?
14. How many kilowatts are used to develop fifty (50) horsepower?
15. What are some metals, which make good conductors of electricity?
16. What are some materials, which make good insulators of electricity?
17. What happens to the resistance if the size of conductor is increased and the length remains the same?
18. What happens to the resistance if the size of a conductor remains constant and the length is increased?
19. What is an electromagnet?
20. How is the strength of an electromagnet determined?
21. What are the most important functions of electromagnets?
22. What is the basic difference between AC and DC power?

23. What are some of the advantages of AC power?

24. Are there any advantages of three-phase AC power in coal mining?

25. Where shall “Danger High Voltage” signs be placed?

26. Where shall trolley wires and trolley feeder wires be guarded?

27. How shall trolley and feeder wires be installed on permanent haulage?

28. What is a disadvantage of direct current in coal mining?

29. What is the effect of distance upon direct current voltage?

30. How can excessive line loss be avoided?

31. How is electricity conducted into mines?

32. What are the standards for temporary splices in low and medium voltage trailing cables?

33. What are the conditions of two or more persons working on an energized high-voltage surface line simultaneously, and any one of them is within reach of another?

34. What type transformers shall be installed underground?

35. What protection must be provided for trolley and feeder wires?

36. How shall splices be made in high-voltage cables used as trailing cables?

37. What are the dangers connected with electric transmission in mines?

38. What are some of the dangers created by the operation of electrical equipment in coal mines?

39. How shall electric conductors on branch circuits be protected against overloads?

40. What is the main consideration in selecting a motor for a particular service?

41. What is the effect of continued overload or undervoltage on operating motors?

42. How can a motor be protected against overload?

43. Under what conditions are diodes permitted? (grounding and polarizing)

44. How can high-voltage lines be disconnected?

45. Where shall circuit breakers protecting high-voltage circuits entering the underground area of a mine be located?

46. What is the purpose of the grounding resistors?
47. What shall be the size of the grounding resistor?
48. What shall be done with underground power circuits on idle days and idle shifts?
49. What protection shall be afforded high voltage cables when installed in mines?
50. What are the standards for cut-out switches or circuit breakers?
51. What protective devices shall be installed on all power wires and cables entering the mines?
52. How does the proper use of fuses or circuit breakers afford protection?
53. Boxes which house contactors and switches should be kept free of what hazard?
54. What are some of the hazards of poor bonding?
55. How must telephone circuits be protected from lightning and contact with high voltage lines.
56. What is the width of contacting metal (flame path) required in a joint for permissibility?
57. What protection should be provided for telephone wires at the entrance to the mine?
58. What can be done to lessen the danger of explosions from operating motors?
59. What kind of telephones must be provided in coal mines?
60. How must electric conductors or branch circuits be protected against overloads?
61. Explain the danger from poorly made splices in a trailing cable?
62. From what must high voltage cables be protected when installed in mines?
63. How does distance affect direct current voltage?
64. How must power wires and cables be installed in shafts and manway compartments?
65. What are some common causes of arcing in motors?
66. What is meant by permissible electrical equipment?
67. What precaution must be taken before repairs are made to a trailing cable?
68. How should the ends of power wires be protected?
69. When trailing cables are not in use what precaution should be practiced?

70. What precaution must be practiced where supervision has ceased?

71. What is the maximum distance between cross bonds?

72. How is the permissibility of equipment commonly destroyed?

73. How must persons be protected from contact with electrical equipment, control and switchboard installations?

74. What is electrolysis?

75. What is the purpose of bonding rails?

76. What is the cause of abnormal heating of conductors?

77. What happens as a result of poor bonding?

78. How can electrolysis be prevented?

79. How should equipment be marked to show it is permissible?

80. How can the dangers of fire from an operating motor be lessened?

81. What is the effect of dust and dirt between the joints of permissible equipment?

82. How often shall energized trolley or bare feeder lines be examined in a coal mine?

83. Where shall insulating platforms of wood, rubber or other suitable non-conductive material be kept?

84. How close to the face area shall trolley wires, trolley feeder wires, high-voltage cables and transformers be located?

85. Where shall bonds be placed on main line tracks?

86. Where shall bonds be placed on secondary track?

87. What is the maximum speed of mobile equipment that requires a reel?

88. What are diodes used for in A.C. power?

89. What are diodes used for in DC power?

90. What type person shall be placed in charge of coal cutting machines in any coal mines?

91. Who is a “qualified person”?

92. What is a zig-zag transformer?

93. What other method (other than diode grounding) is used to frame ground equipment?

94. What is meant by the term “circuit breaker”?

95. What are the standards for the installation of surface transformers?

96. Who must examine all electrical equipment at frequent periods?

97. What shall be done when a potential danger is found on electrical equipment?

98. What is the responsibility of coal companies as related to records of examinations of electrical equipment?

99. What is the meaning of the term ”low voltage”?

100. What is the meaning of the term “medium voltage”?

101. What is meant by wye-connected?

102. What is a delta connection?

103. What is the meaning of the term “neutral point”?

104. What is meant by mine power center or distribution?

105. What is meant by the term derived neutral?

106. What is meant by the term grounded (earthed)?

107. Effectively grounded is a term meaning what?

108. What is meant by ground or grounding conductor (mining)?

109. What is meant by the term borehole cable?

110. What is meant by cable?

111. What is meant by flame resistant cable (portable)?

112. What is a portable (trailing) cable?

113. What is a branch circuit?

114. What is high voltage?

115. What are lightning arrestors?

116. What is face equipment?

117. What is meant by approved?

118. What is mean by permissible?

119. What is an armored cable?

120. How must portable or semi-portable battery charging stations be operated in regard to mine ventilation?

121. When may semi-portable battery charging stations be placed on the intake air current?

122. With what type liquid must capacitors used for power factor correction be filled?

123. What must be provided on capacitors to protect workmen from shock following removal of power?

124. All electrically driven hydraulic systems used at unattended underground loading points must use what type of hydraulic fluid?

125. Who must approve changes made to permissible equipment to be used underground?

126. What must be provided at battery charging stations to prevent the batteries from charging the circuit in even of a power failure?

127. Junction and distribution boxes used for multiple power connections inby the last open breakthrough shall be of what type?

128. Hand held drills, auxiliary fans, pumps and such other low horsepower face equipment taken inby the last crosscut shall be of what type?

129. All electric face equipment taken into or used inby the last open crosscut of any coal mine classified gassy prior to July 1, 1972 must be of what type?

130. All face equipment taken inby (or used) the last crosscut of any coal mine after March 30, 1974 and never classified as gassy shall be of what type?

131. All electric face equipment used inby the last open crosscut of any mine operated entirely above the water table and never classified as gassy must be permissible after what date?

132. Define the term “coal seams above the water table”?

133. After July 1, 1971 in all mines above the water table must use what type of junction or distribution boxes for making multiple power connections inby the last open crosscut?

134. How must all electric face equipment used inby the last open crosscut in mines above the water table be maintained?

135. Except where permissible power connections are used in mines above the water table, where must all power connections points outby the last open crosscut be located?

136. What must be done before maintenance work on power circuits of electric equipment may be performed?

137. Who may be permitted to do work on energized trolley and feeder lines?

138. What equipment must the operator require workmen engaged in performing work on energized trolley and feeder lines?

139. Who may perform work on low-medium-or high-voltage distribution circuits or equipment?

140. What must be done on disconnection devices at power distribution points before work is performed on electrical equipment?

141. Who may remove tags or locks on disconnects so placed at distribution centers?

FIRE PROTECTION

(a) Suitable fire protection shall be provided at surface installations of fans, shops, tipples, and preparation plants, substations, hoist rooms and compressor stations.
(b) Fire drills and demonstration of various types of available fire fighting equipment shall be held for employees at least every six months.
(c) The location of pipe lines, locations of valves, and fire taps shall be shown on a map of the mine and kept available at the mine office at all mines.
(d) Each coal mine shall be provided with suitable fire fighting equipment adapted for the size and condition of the mine. fire fighting equipment required under this article shall meet the following requirements:
    (1) Water lines shall be capable of delivering fifty gallons of water at a nozzle pressure of fifty pounds per square inch.
    (2) A portable water car shall be of at least one thousand gallons capacity, and shall have at least three hundred feet of fire hose with nozzles. A portable water car shall be capable of providing a flow through the hose of fifty gallons of water per minute at a nozzle pressure of fifty pounds per square inch.
    (3) A portable chemical car shall carry enough chemicals to provide a fire extinguishing capacity equivalent to that of a portable water car.
    (4) A portable foam-generating machine shall have facilities and equipment for supplying the machine with thirty gallons of water per minute at thirty pounds per square inch for a period of thirty-five minutes.
    (5) A portable fire extinguisher shall be either a multipurpose dry chemical type, containing a nominal weight of five pounds of dry powder and enough expellant to apply the powder; or a foam-producing type containing at least two and one-half gallons of foam-

producing liquid and enough expellant to supply the foam. Only fire extinguishers approved by the Underwriters Laboratories, Inc. of Factor Mutual Laboratories, carrying appropriate labels as to type and purpose shall be used after July 1, 1971, and all new portable fire extinguishers acquired for use in a coal mine shall be of the multipurpose dry chemical type, having a 2A 10BC or higher rating.

(6) The fire hose shall be rubber-lines, mildew-proof and the cover shall be of flame-resistant qualities, meeting requirements for hose in Bureau of Mines Schedule 2G, except that the test flame shall be applied to the outer surface rather than to an open end. The bursting pressure shall be at least four times higher than the static water at the mine location; the maximum water pressure in the hose nozzle shall not exceed 100 p.s.i.g.

(e) Each working section of coal mines producing three hundred tons or more per shift shall be provided with two portable fire extinguishers and two hundred forty pounds of bagged rock dust; waterlines shall extend to each section loading point and be equipped with enough fire hose to reach each working face unless the section loading point is provided with one of the following: (1) Two portable water cars or (2) two portable chemical cars, or (3) one portable water car or one portable chemical car and either a portable foam-generating machine or a portable high-pressure rock dusting machine, fitted with at least two hundred fifty feet of hose and supplied with at least sixty sacks of rock dust.

(f) In all coal mines, waterlines shall be installed paralleled to the entire length of belt conveyors and shall be equipped with fire hose outlets with valves at three hundred foot intervals along each belt conveyor and at tailpieces.

At least five hundred feet of fire hose with fittings suitable for connection with each belt conveyor waterline system shall be stored at strategic locations along the belt conveyor. Waterlines may be installed in entries adjacent to the conveyor entry belt as long as the outlets project into the belt conveyor entry.

Each working section of coal mines producing less than three hundred tons of coal per shift shall be provided with two portable fire extinguishers, two hundred forty pounds of bagged rock dust and at least five hundred gallons of water and at least three pails of ten quart capacity. In lieu of the five hundred gallon water supply, a waterline with sufficient hose to reach the working places, a portable water car of five hundred fifty gallons capacity, or a portable all-purpose dry powder chemical car of at least one hundred twenty-five pounds capacity may be provided.

(g) In mines producing three hundred tons of coal or more per shift, waterlines shall be installed parallel to all haulage tracks using mechanized equipment in the track or adjacent entry and shall extend to the loading point of each working section. Waterlines shall be equipped with outlet valves at intervals of not more than five hundred feet, and five hundred feet of fire hose with fittings suitable for connection with such waterlines shall be provided at strategic locations. Two portable water cars, readily available, may be used in lieu of waterlines prescribed under this paragraph.

(h) In mines producing less than three hundred tons of coal per shift, there shall be provided at five hundred foot intervals in all main and secondary haulage roads:

(1) A tank of water of at least fifty-five gallon capacity with at least three pails of not less than ten-quart capacity, or

(2) Not less than two hundred forty pounds of bagged rock dust.

(i) Each track or off-track locomotive, self-propelled man-trip car, or personnel carrier shall be equipped with one portable fire extinguisher.

(j) Two portable fire extinguishers shall be provided at each permanent electrical installation. One portable fire extinguisher and two hundred forty pounds of rock dust shall be provided at each temporary electrical installation.

(k) Two portable fire extinguishers and two hundred forty pounds of rock dust shall be provided at each permanent underground oil storage station. One portable fire extinguisher shall be provided at each working section where twenty-five gallons or more of oil are stored in addition to extinguishers required under paragraph (e) of this section. (1) One portable fire extinguisher or two hundred forty pounds of rock dust and water shall be provided at locations where welding, cutting, or soldering with arc or flame is being done.

(l) At each wooden door through which power lines pass there shall be one portable fire extinguisher or two hundred forty pounds of rock dust within twenty-five feet of the door on the intake air side.

(m) At each mine producing three hundred tons of coal or more per shift, there shall be readily available the following materials at locations not exceeding two miles form each working section:

(1) One thousand board feet of brattice boards
(2) Two rolls of brattice cloth
(3) Two hand saws
(4) Twenty-five pounds of 8˚ nails
(5) Twenty-five pounds of 10˚ nails
(6) Twenty-five pounds of 16˚ nails
(7) Three claw hammers
(8) Twenty-five bags of wood fiber plaster of ten bags of cement (or equivalent material for stoppings)
(9) Five tons of rock dust

(n) At each mine producing less than three hundred tons of coal per shift, the above materials shall be available at the mine; provided, however, that the emergency materials for one or more mines may be stored at a central warehouse or building supply company and such supply must be the equivalent of that required for all mines involved and within one hours delivery time from each mine. this exception shall not apply where the active working sections are more than two miles from the surface.

ANSWER SHEET FOR BASIC ELECTRICITY

1. Volt (E).
2. Ampere (I).
3. An ammeter.
4. A voltmeter.
5. Watt (W).
6. A watt-hour meter.
7. Ohm (R)
8. Ohm meter.
9. Amperes = $\frac{\text{watts}}{\text{volts}}$ (I=$\frac{W}{E}$) or $\frac{\text{volts}}{\text{ohms}}$ (I=$\frac{E}{R}$)

10. volts = $\frac{\text{watts}}{\text{amperes}}$ $\left(E = \frac{W}{I}\right)$ or amperes x ohms (E=IR)
11. Watts = amperes x volts (W= IE)
12. Seven hundred and forty-six (746).
13. One thousand (1000) watts.
14. 37.3 KW
15. Copper, aluminum, gold, silver and steel.
16. Dry air, shellac, rubber, glass, mica, silk, varnish and dry wood.
17. The resistance is decreased.
18. The resistance is increased.
19. A magnet created by passing a current through a coil wound around a soft-iron core.
20. By the number of ampere turns. The number of turns of wire in the coil times the amount of current flowing through the coil.
21. Their use in generators, motors, and in the operation of contactors and linestarters.
22. In DC power the direction of current flow does not change. In AC power the current flow is constantly changing direction and magnitude.
23. A high voltage can be maintained through transformers; little line loss due to the ability to transmit a high voltage of low current.
24. Yes, the use of AC is much safer and efficient.
25. They shall be placed conspicuously on all transformer enclosures, high-potential switch-boards, and other high potential installations.
26. (1) At all points where men are required to work or pass regularly under the wires.
    (2) On both sides of all doors and stoppings.
    (3) At man trip stations.
    (4) Temporary guards shall be provided where trackmen and other persons work in proximity to trolley wires and trolley feeder wires.
27. (1) At least six inches outside the track gauge line.
    (2) Kept tight and not permitted to touch the roof, rib, or crossbars – (timbers).
    (3) Where trolley or trolley feeders pass through door openings – no bare wires shall come in contact with combustible material.
    (4) Wire hanger shall be provided within three feet of each splice in trolley wire.
28. The comparatively low voltage desirable for mines can be used economically only within a limited distance from its source of generation.
29. The voltage is decreased by line drop due to the resistance of the conductors.
30. By ample current carrying capacity in the conductors, by adequate bonding, and by locating generating sets near the point of operation.
31. By means of suitable conductors, usually copper.
32. (1) Only one splice shall be made.
    (2) Trailing cables with temporary splices may only be used for the next twenty-four hour period.
    (3) No temporary splice shall be made in a trailing cable within twenty-five feet of the machine, except cable reel equipment.
    (4) Temporary splices shall be mechanically strong and well insulated.
    (5) Trailing cables or hand cables which have exposed wire or which have splices that heat or spark under load shall not be used.
33. Such persons shall not be allowed to work on different phases or on equipment with different potentials.
34. Transformers which are air cooled or cooled with non-flammable liquid or inert gas.

35. They shall be provided with overcurrent protection.
36. No temporary splices shall be made and permanent splices shall be made in accordance with the manufacturers specifications.
37. Electric shock hazard, fires and explosions from short circuits.
38. Fires from overheated equipment and explosions from unguarded flashes or arcs.
39. By fuses or suitable overload devices.
40. That it has sufficient rated capacity and the proper characteristics for the service intended.
41. Heating will destroy the insulation.
42. By fuses or by overload relays.
43. (1) Installation of silicon diodes shall be restricted to electric equipment receiving power from a direct current system with one polarity grounded.
    (2) Where such diodes are used on circuits having a nominal voltage rating of two hundred fifty (250V), they must have a forward current rating of four hundred amperes (400A) or more, and have a peak inverse voltage rating of four hundred (400V) or more.
    (3) Where such diodes are used on circuits having nominal voltage rating of five hundred fifty(550V), they must have a peak inverse voltage rating of eight hundred (800V) or more.
    (4) In addition to the grounding diode, a polarizing diode must be installed in the machine control circuit to prevent operation of the machine when the polarity of a trailing cable is reversed.
    (5) When installed on permissible equipment all grounding diodes, over current devices, and polarizing diodes must be placed in explosion proof compartments.
44. Fused tongs or pullers or insulated sticks, and high-voltage gloves.
45. They shall be located on the surface and in no case installed either underground or within a drift.
46. To limit the ground fault voltage (high voltage circuits), and to limit fault current in low and medium voltage circuits to 25 amps.
47. It shall be of the proper ohmic value to limit the voltage drop in the grounding circuit external to the resistor to not more than one hundred volts under fault conditions.
48. They shall be de-energized except that rectifiers and transformers may remain energized.
49. (1) They shall be installed only in regularly inspected air courses and haulageways.
    (2) They shall be covered, buried, or placed so as to afford protection against damage.
    (3) When passing under haulageways they should be protected by not less than four inches of concrete.
50.
(412-413) (1) Circuit breakers and disconnecting switches shall be marked for identification.
    (2) Disconnecting devices shall be installed at the beginning of branch lines in underground high voltage circuits and equipped or designed in such manner that it
(407-411) can be determined by visual observation that the circuit is de-energized when the switches are open.
    (3) Trolley wires and trolley feeder wires shall be provided with cutout switches at
(502-505) intervals of not more than two thousand feet and near the beginning of all branch lines.
    (4) One circuit breaker may be used to protect two or more branch circuits, if the circuit
(341-343) breaker is adjusted to afford overcurrent protection for the smallest conductor.
    (5) In all main power circuits, disconnecting switches shall be installed underground within five hundred feet of the bottom of shafts and boreholes through which main
(165-171) power circuits enter the underground are of the mine and within five hundred feet of all other places where main power circuits enter the underground are of the mine and

all branch lines.

(6) Automatic circuit-breaking devices or fuses of the correct type and capacity shall be installed so as to protect all electric equipment and circuits against short circuits and overloads.

(152-155)

51. Each ungrounded, exposed power conductor that leads underground shall be equipped with **suitable lightning arrestors** of approved type within one hundred feet of the point where the circuit enters the mine.
52. By opening automatically when a short circuit or an overload occurs.
53. Coal dust.
54. (1) Mine fires and explosions.
    (2) Electric shocks.
    (3) Stray current.
    (4) Electrolysis
55. By the use of approved protective devices and lightning arrestors.
56. Generally one (1) inch.
57. Properly grounded lightning arrestors.
58. By using permissible electrical equipment and maintaining it in a permissible manner.
59. Permissible telephones.
60. By suitable overload devices or fuses.
61. Poor splices will heat and may short circuit.
62. Against moisture and mechanical damage.
63. Voltage is decreased by line drop due to resistance.
64. Properly insulated, substantially fastened and well protected.
65. (1) Poor connections.
    (2) Uncleanliness
    (3) Defective parts.
66. Equipment similar in all respects to that which has been approved by the United States Bureau of Mines.
67. The power must be cut off, visually disconnected, and locked out.
68. Sharp projecting ends must be covered by insulating material.
69. the power should be cut off.
70. The current must be disconnected.
71. Not more than 200 feet.
72. By improper maintenance.
73. By adequate fencing or guarding and by heavy rubber mats or insulated platforms.
74. Action of an electric current which carries away particles of a conductor.
75. To provide a continuous return circuit of low resistance.
76. Insufficient carrying capacity, poor connections, low voltage or overloads.
77. Poor electrical transmission and hazard such as fires and explosions.
78. By proper bonding of rails.
79. A U.S. Bureau of Mines approval plate.
80. (1) By protective devices.
    (2) Workmanlike installation
    (3) Clean incombustible surroundings.
81. Permissibility is destroyed when the joint cannot be closed tightly enough to provide the required cooling action.
82. Not less than every eight (8) hours **by a certified foreman or fire boss.**
83. At each switchboard and at stationary machinery where shock hazards exist.

84. They cannot be closer than fifteen feet from the last open crosscut and shall be kept at least one hundred fifty feet from pillar workings.
85. Rails and switches shall be bonded and cross-bonded in such a manner to provide an adequate return.
86. At every track joint on one rail and cross-bonded at intervals of not less than two hundred (200) feet. However, if a ground wire parallels the track and is connected to the track at intervals of not more than two hundred (200) feet, the rail joints need not be bonded.
87. Two and one half (2 1/2) miles per hour.
88. Rectifing AC power to DC power.
89. Frame grounding.
90. A qualified person, capable of determining the safety of the roof and sides of the working places and of detecting the presence of explosive gas, unless they are accompanied by a certified or qualified person who has passed such an examination.
91. A person who has completed an examination and is considered qualified on record by the Utah Labor Commission.
92. The term zig-zag transformer shall mean a transformer intended primarily to provide a neutral point for grounding purposes.
93. A ground conductor attached to the frame of the machine.
94. A device used for the interruption of a circuit between separable contacts during normal or abnormal conditions.
95. All surface transformers, unless of a construction which will eliminate shock hazards, or unless installed at least eight feet above ground, shall be enclosed in a house or surrounded by a fence at least six feet high. If the enclosure is of metal, it shall be grounded effectively. The gate or door to the enclosure shall be kept locked at all times, unless authorized persons are present.
96. A qualified person, why? To assure safe operating conditions. Examinations performed weekly.
97. Such equipment shall be removed from service until such condition is corrected.
98. A record of such examinations shall be kept and made available to an authorized representative of MSHA and to the miners in such mine.
99. The term “low voltage” shall mean up to and including six hundred sixty volts (660V).
100. Voltage from six hundred sixty-one (661) to one thousand (1000) volts.
101. A power system connection in which one end of each phase windings of transformers or AC generators are connected together to from a neutral point, and a neutral conductor may or may not be connected to the neutral point, and the neutral point may or may not be grounded.
102. A power system in which the windings of transformers or AC generators are connected to form a triangular phase relationship and with phase conductors connected to each point of the triangle.
103. The connection point of transformer or generator windings from which the voltage to ground is nominally zero, and is the point generally used for system groundings in wye-connected AC power system.
104. Combined transformer or distribution unit within a metal enclosure from which one or more low voltage power circuits are taken.
105. A neutral point established by the addition of a zig-zag or grounding transformer to a normally undergrounded power system.
106. The system, circuit or apparatus is provided with a ground.
107. Grounded through a connection of sufficiently low impedence so that ground faults which may occur cannot build up voltages in excess of limits established for apparatus, circuits, or systems so grounded.
108. A metallic conductor used to connect the metal frame or enclosure of any equipment, device or wiring system with a mine track or other effective grounding medium.

109. A cable designed for vertical suspension in a borehole or shaft.
110. A standard conductor may be single conductor or multiple conductors insulated from each other.
111. A portable cable that has passed the flame test of the Federal Bureau of Mines.
112. A flexible cable or cord used for connecting mobile, portable, or stationary equipment where permanent mine wiring is prohibited or impracticable.
113. Any circuit AC or DC connected to and leading from the main power line.
114. Voltage of more than 1,000 volts.
115. A protective device for limiting surge voltage.
116. Mobile or portable mining machinery having electric motors operated inby the last open crosscut.
117. In strict compliance with mining law.
118. Any equipment, device, or explosive that has been approved by the U.S. Bureau of Mines.
119. A power cable wrapped with metal, usually steel wires or tapes, primarily for the purpose of mechanical protection.
120. Placed on a separate split of air.
121. If fifteen thousand (15,000) cubic feet of air per minute is circulated for one (1) try of batteries, and five thousand (5,000) cfm more for each additional tray this applies to a four (4) hour charging rate.
122. Non-inflammable liquid.
123. Drain off resistors.
124. A fireproof oil or emulsion.
125. Director of the Department of Mines and the United States Bureau of Mines.
126. Reverse current relays.
127. Permissible
128. Permissible
129. Permissible.
130. Permissible.
131. On and after March 30, 1974.
132. Any coal seam at an elevation above a river, or one of its tributaries, into which surface water naturally drains.
133. Permissible.
134. In a permissible condition.
135. On intake air.
136. Circuits must be de-energized, visually disconnected, and locked out except for trouble shooting or testing.
137. Only by persons trained to perform this type work.
138. Such workmen shall be required to wear approved and tested insulated shoes and wireman's gloves.
139. Only by qualified persons trained to perform such work and under the direction of a qualified person.
140. Disconnects shall be locked out and tagged by the person who performs the work. If locking out is not possible , the disconnects shall be opened and suitably tagged.
141. They must be removed by the person who installed them, or if unavailable, by a qualified person authorized by the operator.

CHAPTER SEVEN

FIRES AND EXPLOSIONS

1. Sealing Mine Fires
2. Unsealing Mine Fires
3. Explosions and Recovery
4. Mine Rescue Crews
5. Mine Rescue Teams
6. Mine Rescue
7. Fires & Explosions

FIRES AND EXPLOSIONS
SEALING MINE FIRES

1. What are the principle causes of mine fires?
2. What hazard may be created by wooden structures inside a mine.
3. What methods have been used to control or extinguish mine fires?
4. How may rock dust be used effectively to extinguish a mine fire?
5. Under what conditions may rock dust be used to extinguish a mine fire?
6. What advantage does rock dust have over the use of water in extinguishing a mine fire?
7. What is the most effective means of applying rock dust to a mine fire?
8. What is the safest and most effective means of controlling serious mine fires?
9. When should a mine fire be sealed?
10. When is it advisable to fight a mine fire by flooding?
11. Why is it not advisable to fight a mine fire by flooding?
12. What is the object of sealing a mine fire?
13. What are the principle hazards in sealing mine fires?
14. What changes occur to the atmosphere sealed within a fire area?
15. What is the first thing to do upon discovery of a raging mine fire?
16. Under what circumstances may methane accumulate in the presence of fire without the danger of an explosion?
17. What is the principle danger while mine fires are being sealed?
18. How may the danger of an explosion be minimized while sealing a fire area?
19. What kind of fire seals should be erected first?
20. Why should temporary seals be erected first to seal a mine fire?
21. What material should be used for temporary fire seals?
22. How does a temporary seal exclude oxygen from the fire area?

23. During what period after a fire seal has been erected is there danger of an explosion?

24. What are the essential requirements of permanent fire seals?

25. How may permanent fire seals be made relatively airtight?

26. Of what material should permanent fire seals be constructed?

27. What facilities should be provided in permanent fire seals?

28. By what means can the condition of the fire in a sealed area be indicated?

29. How can excessive internal pressure be relieved from a sealed area without permitting air to enter?

30. What would a continued high oxygen content in a sealed fire area indicate?

31. What would a fluctuating high carbon monoxide concentration in a sealed fire area indicate?

32. How would an air analysis indicate that the fire was extinguished?

33. What are the two most dangerous gases encountered in mine fires?

34. How does the action of a mine fire cause explosive gases to be formed?

35. How may the danger of an explosion following a mine fire be minimized?

36. What is the primary consideration in fighting mine fires?

37. What is the danger of reversing the air current in the event of a mine fire?

38. In what way may the possibility of mine fires be lessened?

39. What combustible and dangerous gas may be formed by the application of water to a mine fire?

40. How may gob fires in abandoned areas be avoided?

41. In the event of a mine fire, located on the return from an extremely gassy section, what precaution should be taken?

42. In the event of a mine fire discovered on the intake, what should be done to protect the men inside the mine from smoke and dangerous gases?

43. In the event of a mine fire in a gassy mine, how should the fire be approached?

44. What precautions should be taken to protect those engaged in attempting to extinguish a mine fire?

45. In the event of a mine fire in a gassy mine, should the fan be stopped?

46. How long a period is arbitrarily set, after temporary seals are erected, before men are permitted to return to the seals for investigation?

UNSEALING MINE FIRES

47. What should be done to determine when a fire area should be opened?

48. What does the presence of carbon monoxide in a sealed fire area indicate?

49. What should be totally absent from the air samples before an attempt is made to unseal a mine fire?

50. What deficiency of oxygen in a methane-air mixture renders an explosion impossible?

51. Why is it not advisable to unseal a fire shortly after the carbon monoxide has disappeared and the oxygen content is reduced to about one (1%) percent?

52. To what per cent should oxygen be reduced before it is advisable to attempt to open a fire seal?

53. Why is it necessary to have a low oxygen content before a fire seal is opened?

54. How should ventilation be restored to a fire area?

55. Why should the ventilation be restored to the fire area gradually and systematically after unsealing?

56. What is the effect on the extinguishment of a mine fire under seal by carbon dioxide generated by the fire?

57. What preparatory work is necessary, prior to unsealing a mine?

58. Why should careful consideration be given to the problem of unsealing a fire area?

59. What is the major consideration in determining when a fire seal should be broken?

60. What is the comparative effect upon oxygen between a raging fire and a smoldering fire?

61. How will an oily shale roof and a high volatile coal affect conditions otherwise favorable to reopening a fire seal?

62. How may a sealed fire area between intake and return airways be affected by the difference in pressure?

63. What effect does barometric pressure have upon a sealed fire area?

64. Under what conditions may a sealed fire area be re-ventilated quickly?

65. When should air locks be used to recover a fire area?

66. How may bodies be recovered from a sealed fire area before the fire has been extinguished?

67. What is the procedure in using air locks to recover a sealed fire area?

68. What is the procedure when a sealed fire area is recovered by direct ventilation?

69. To what extent should electricity be permitted in a mine during the unsealing of a fire area?

EXPLOSIONS AND RECOVERY

70. What are the principle causes of mine explosions?

71. What is the most prevalent source from which mine explosions are started?

72. What is the principle cause of accumulations of explosive mixtures of methane?

73. What is the most common cause of interrupted ventilation?

74. What is the principle cause of ignition of explosive mixtures?

75. How can mine explosions be prevented?

76. What can be done to prevent a possible explosion from being propagated by coal dust?

77. What is the first thing to be done on the surface of a mine in the event of an explosion?

78. What is the most important duty of the electrician in the event of a mine explosion?

79. With ventilating apparatus working properly, what precaution should be taken to protect the lives of possible survivors?

80. What should be the duty of police guards in the event of a mine explosion?

81. What should be the duty of the mining engineer in the event of a mine explosion?

82. What agency shall be notified immediately in the event of a mine explosion?

83. How many men should be placed in charge of crews on each shift in the work of recovery after a mine explosion?

84. Who is eligible to be placed in charge of crews on each shift in the work of recovery after a mine explosion?

85. What minimum number of apparatus crews should be employed at a time underground in the work of recovery after a mine explosion?

86. What precautions should be taken before men are permitted to enter a mine following an explosion, assuming that fans are operating properly?

87. What kinds of workers should be on each shift in recovery work following a mine explosion?

88. What qualifications should be possessed by men on oxygen breathing apparatus crews?

89. What equipment should rescue parties wear?

90. What means of gas detection should be provided rescue parties?

91. What material should be provided for recovery work?

92. What ventilation instrument should be provided for recovery work?

93. What first-aid equipment should be provided for recovery work?

94. What fire-fighting equipment should be provided for recovery work?

95. In recovery work at what point underground is it advisable to have a first-aid station?

96. Before proceeding into a mine after an explosion, what examination should be made?

97. What particular danger is present if ventilation is restored following an explosion, before an exploration is made?

98. What are the chief factors that determine the location and establishment of a fresh-air base in mine recovery work?

99. What breathing apparatus may be used for exploration beyond fresh air?

100. What atmospheric conditions will not permit the use of an all-service gas mask?

101. Where is it essential that self-contained oxygen breathing apparatus be used?

MINE RESCUE CREWS

The director of the department of mines is herby authorized to have trained and employed at the rescue station, operated by the department within the state, such rescue draws as he may deem necessary.

Each member of a rescue crew shall devote four hours each month, for training purposes and shall be available at all times to assist in rescue work at explosions and mine fires.

Regular members shall receive for such services the sum of thirty-two dollars per month, and captains shall receive thirty-five dollars per month, payable on requisition approved by the director of the department of mines.

The director of the department of mines may remove any member of a rescue crew at any time.

After the effective date of this article, it shall be the duty and responsibility of the department of mines to see that all rescue teams be properly trained by a qualified instructor of the department of mines or such persons who have a certificate of training from the U.S. Bureau of Mines.

To qualify for membership of a mine rescue crew, an applicant shall: (a) be not more than fifty years of age; (b) pass a physical examination by a licensed physician at least annually.

A record that such examination was taken together with pertinent data relating thereto shall be kept on file by the operator, and a copy shall be furnished to the director of the department of mines.

All rescue or recovery teams performing recovery work shall be under the jurisdiction of the department of mines guided by the mine rescue apparatus and auxiliary equipment manual.

When engage in rescue work required by an explosion, fire or other emergency at a mine, all members of mine rescue teams assigned to rescue operations shall.

During the period of their rescue work, be employees of the operator of the mine where the emergency exists, and shall be compensated by the operator at the rate established in the area for such work.

In no case shall this rate be less than the prevailing wage rate in the industry for the most skilled class of inside mine labor.

During the period of their emergency employment, members of mine rescue teams shall be protected by the workmen’s compensation subscription of such emergency employer.

During recovery work and prior to entering any mine at the start of each shift, all rescue or recovery teams shall be properly informed of existing conditions and work to be performed by the designated company official in charge.

For every two teams performing rescue or recovery work underground, one six-member team shall be stationed at the mine portal.

Two-way communication and lifeline or its equivalent shall be provided inby the fresh air base to all rescue or recovery teams, and no team member shall be permitted to advance beyond such communication systems.

Each rescue or recovery team performing work with breathing apparatus shall be provided with a back up team of equal strength, stationed at each fresh air base.

A rescue or recovery team shall immediately return to the fresh air base when any team member's atmospheric pressure depletes to sixty atmospheres.

MINE RESCUE TEAMS

It shall be the duty of any mine operator employing fifty or more employees to have available for mine rescue work a trained mine rescue team, the members of which shall work in the general area of the mine.

In the event of any fire, explosion or recovery operations in or about any mine, the director of the department of mines is hereby authorized to call and assign any rescue team for the protection of employees and the preservation of property.

The director also may assign mine rescue and recovery work to inspectors, instructors, or other qualified employees of the department of mines as he may deem desirable.

102. What percentages of methane in a methane air mixture, when burned or exploded, will produce relatively large amounts of carbon dioxide?

103. What percentages of methane in a methane-air mixture, when burned or exploded, will produce relatively large amounts of carbon monoxide?

104. What should the captain of an apparatus crew do before leaving the fresh-air base?

105. What is the procedure of an apparatus crew engaged in exploration?

106. How far apart should the members of an apparatus crew travel?

107. How should apparatus crews keep in contact with each other and the fresh-air base?

108. What is the advisable distance an apparatus crew should explore when lives are not at stake?

109. What is the maximum distance an apparatus crew should explore under favorable conditions when lives are at stake?

110. What is the length of a standard mine rescue life-line?

111. What is the recommended life-line signal to stop if traveling or "all right" if at rest?

112. What is the recommended life-line signal for “advance”?

113. What is the recommended life-line signal for “distress”?

114. How should the life-line be carried at all times?

115. Is it advisable to explore ahead of fresh air to dense smoke?

116. Under what conditions is it inadvisable to explore ahead of fresh air in a gassy atmosphere?

117. Under what conditions of travel is it inadvisable to explore ahead of fresh air?

118. Under what condition of temperature is it inadvisable to explore beyond fresh air?

119. What conditions of the self-contained oxygen breathing apparatus would make it inadvisable to explore beyond fresh air?

120. When is it advisable to explore beyond fresh air when only one apparatus crew is in the mine?

121. In the course of recovery work, if men are discovered alive but not physically fit to travel on their own strength, how should they be treated?

122. Why should men be kept at the fresh-air base after rescue until partially recuperated?

123. When re-establishing ventilation for recovery operations after an explosion, what type of stoppings should be used?

124. What should be done when fires are found during recovery explorations?

125. Why is it advisable to have telephones at the fresh-air base?

126. Why should maps of the mine be available for the men in charge of recovery?

127. Where should the shifts be changed when recovery work is in progress?

128. What precautions should be taken when men are coming off shift from recovery operations?

129. What precautions should be observed by men as they advance in the process of restoring ventilation?

130. When ventilation is being restored, what precautions should be taken at open dead ends and other open areas encountered?

131. What is the most harmful gas in afterdamp?

132. What is a barricade?

133. Have barricades been successful in preserving life following mine fires and explosions?

134. How may barricades be constructed?

135. In the even of an explosion and escape is cut off by after damp in all escapeways, what is the safest thing to do?

136. What can be done to prevent the gases of an explosion from reaching the point where a barricade is intended?

137. How large an area should be enclosed within a barricade?

138. While within a barricade how should a person conduct himself?

139. What should be done with flame lamps within a barricade?

140. How can compressed air, if available, be of assistance within a barricade?

141. How much air does the average person require per hour within a barricaded area when at rest?

142. For what approximate length of time may five (5) men be barricaded in an area one hundred (100) feet long, ten (10) feet wide and five (5) feet high before they begin to suffer from oxygen depletion?

143. When gases begin to enter a barricade, what can be done?

SAMPLE QUESTIONS FOR MINE RESCUE

1. What is the purpose of the Mine Emergency Notification Plan?
    e. It describes how the mine operator will notify MSHA and state officials of amine emergency
    f. It outlines the procedures used to notify mine rescue team members when their services are required
    g. It describes the procedures used to notify all miners working underground of an emergency situation
    h. It designates the person responsible for notifying the local emergency responders (police, EMT's, fire-fighters)

2. The records (MSHA 5000-3) certifying the medical fitness of the mine rescue team members shall be maintained by _____.
    a. The Utah Labor Commission Mine Certification Official
    b. The mine operator
    c. Each individual mine rescue team member
    d. MSHA District 9

3. 30 CFR, Part 49 requires that each operator of an underground mine have _____ mine rescue teams available _____.
    a. Three, when miners are underground
    b. Two, when miners are underground
    c. Two, at all times
    d. Three, at all times

4. A member of a mine rescue team has missed 12 hours of scheduled training in the past year. Is it permissible for the mine operator to use him on a mine rescue team.
    a. Yes, as long as his part 48 annual refresher training requirements are current
    b. No, he must meet the training hours prescribed in 30 CFR, Part 49.8
    c. Yes, as long as he has at least 5 years of experience on a mine rescue team

5. Which of the following is **not** taken into consideration in determining whether a miner is physically capable of performing mine rescue duties?
    a. High or low blood pressure
    b. A history of seizures
    c. Hernia
    d. A minimum height requirement

6. A Utah coal mine could meet the requirements for special mining conditions which allows alternative mine rescue capability.
    a. True, if less than 50 miners are employed
    b. True, as long as methane levels are well below the average for the coal mines in the state
    c. False, coal is combustible
    d. False, this allowance is only for "low back" coal mines

7. How often must refresher training for mine rescue teams be conducted underground?
    a. At least once each 6 months
    b. There is no requirement to conduct the training underground as long as the required subjects are covered
    c. Annually
    d. It varies depending on training guidance provided by MSHA

8. A miner must have 20/20 vision to be a member of a mine rescue team.
    a. True
    b. False
    c. True, but it can be corrected to 20/20 with glasses

9. All members of a mine's mine rescue teams must be employees of that mine operator.
    a. True
    b. False

10. Which of the following is **not** required in a mine rescue station?
    a. Twelve self-contained oxygen breathing apparatus
    b. Twelve permissible cap lamps and a charging rack
    c. Two oxygen indicators
    d. A complete first aid kit including an evacuation stretcher

SAMPLE QUESTIONS FOR FIRES AND EXPLOSIONS

1. Which is a class "C" fire?
    a. Burning trash
    b. Burning fuel
    c. Electrical fires
    d. None of the above

2. What can be done to prevent a possible explosion from being propagated by coal dust?
    a. Use of permissible diesel equipment
    b. Use of permissible electrical equipment
    c. Use of rock dust
    e. Use of permissible explosives

3. How can compressed air be of assistance in a barricade?
    a. It can be used to build up internal pressure
    b. It can be used to build up external pressure
    c. It can be used to replenish the oxygen
    d. Compressed air should not be used in a barricade
    f. None of the above

4. What fire protection shall be provided at permanent oil stations?
    a. 240 pounds of rock dust
    b. Two portable fire extinguishers or the equivalent and 240 pounds of rock dust
    c. 240 pounds of rock dust and 4 portable fire extinguishers
    d. 280 pounds of rock dust and 2 portable fire extinguishers
    e. None of the above

5. How much time must a member of a mine rescue team devote to training each month or every other month?
    a. 2 hours every month or 8 hours every other month
    b. 4 hours every month or 8 hours every other month
    c. 16 hours every month or 24 hours every other month
    d. 24 hours every month or 48 hours every other month
    e. None of the above

6. What methods are effective for rendering coal float dust non-explosive?
    a. Clean up and removal, wetting down, and rock dusting
    b. Calcium chloride
    c. Adequate water sprays, with adequate pressure on mining equipment
    d. Maintaining sharp cutting bits on mining equipment and adequate ventilation
    e. All of the above

7. What is the effect of an explosion upon the respirable air in the explosion area?
    a. Oxygen is depleted and carbon monoxide is formed
    b. Hydrogen sulfide is depleted and oxygen is increased
    c. Carbon monoxide is depleted and methane is formed
    d. Methane is increased and carbon dioxide is depleted
    e. None of the above

8. In the event of an explosion or a serious mine fire and escape is not cut off, the safest thing to do is _____.
    a. Put on a self-rescuer and get to fresh air as soon as possible
    b. Construct a barricade as soon as possible
    c. Call the General Foreman for instructions
    d. Call for the mine rescue team

9. What is the safest and most effective way of fighting a serious mine fire which is determined to be out of control?
    a. By direct attack with water
    b. By carbon dioxide fire extinguishers
    c. By sealing
    d. By increasing ventilation
    e. None of the above

10. Before entering any mine to perform rescue or recovery work, all teams must be properly informed of _____.
    a. Methods of gas testing
    b. Existing conditions
    c. The places where water is to be found
    d. Methods of hanging line curtains
    e. All of the above

ANSWER SHEET FOR
FIRES AND EXPLOSIONS
SEALING MINE FIRES

1. Open lights, smoking, electric sparks, heating of electrical equipment, ignition of gas, blasting, and spontaneous combustion.
2. The hazard of fires.
3. (a) Chemicals, cardox, rock dust, or sand.
   (b) Enclosing affected area with tight seals.
   (c) Flooding affected areas.
   (d) Foam.
4. By coating the fire with a thick layer of rock dust.
5. When the fire can be approached near enough so that rock dust can be directed upon the burning material.
6. Rock dust can be carried by the air current and deposited upon the fire; it eliminates the formation of steam and water gas; the use of rock dust also protects the roof from disintegration caused by steam and water.
7. By the use of a high-pressure rock dusting machine.
8. By sealing.
9. Whenever it is not reasonably safe to employ direct methods of fighting it.
10. Only when it is otherwise inaccessible and local conditions are favorable.
11. (a) Heavy damages to mine and equipment.
    (b) Expense of dewatering.
    (c) Impossibility of ascertaining if fire is extinguished.
    (d) Period of non-productivity.
    (e) Possibility of generating explosive and dangerous gases by insufficient amount of water on fire area.
12. To cut off the supply of oxygen.
13. Explosive and asphyxiating gases.
14. Carbon dioxide and carbon monoxide are increased, oxygen is depleted and explosive gases may accumulate.
15. Withdraw all men from the mine, except those engaged in fighting the fire.
16. When the rate of liberation is not sufficient to produce an explosive mixture before the oxygen has been reduced to twelve (12%) percent.
17. The danger of a gas explosion.
18. By sealing sufficiently far away to prevent explosive mixtures from forming before the fire seals can be completed.
19. Temporary seals.
20. Quickness of erection lessens the exposure of the men to the danger of an explosion.
21. Multiple layers of brattice cloth or plastic tight against ribs, roof and floor, or plastered wood seals.
22. Leakage of air is reduced by the expansion of the heated atmosphere which produces a pressure on the inside of the seal.
23. While the oxygen content remains above twelve percent (12%).
24. They should be as airtight as possible.
25. By “hitching” them into the floor, roof and ribs, and coating the seals.
26. They should be substantially constructed of incombustible material.

27. Pipes should be provided through which air samples may be collected and excessive internal pressures can be bled.
28. By analyses of air samples collected from behind the seals.
29. By bleeding off through a water trap.
30. That there is a leakage of air into the sealed area.
31. That there is a leakage of air into the sealed area, keeping the fire active.
32. By low oxygen content and the absence of carbon monoxide.
33. Carbon monoxide and methane.
34. By distillation of combustible gases from the coal and surrounding carbonaceous shales and by chemical reaction between carbon of the coal, oxygen of air and coal, and hydrogen from water at the higher temperature.
35. By sealing a large area enclosing the fire.
36. To provide for the safety of the men engaged in the work.
37. Inflammable gases formed by the fire may become explosive when mixed with fresh air and may explode when drawn across the fire.
38. By the use of closed lights, permissible explosives, approved electrical installations, sealing of abandoned areas, and careful supervision.
39. Water gas (carbon monoxide and hydrogen).
40. By sealing to exclude oxygen.
41. The air should be short-circuited to prevent the gas from being carried across the fire area.
42. The air from the fire should be short-circuited from the men.
43. Cautiously from the intake side by a competent person using a CO detector, to determine the condition of the atmosphere.
44. The fire-fighting crew should be protected with fresh air or be equipped with all-service gas masks or oxygen breathing apparatus.
45. Only when so decided by men in charge who are experienced in rescue and recovery operations. (Usually inadvisable).
46. Seventy two (72) hours or longer.

ANSWER SHEET FOR
UNSEALING MINE FIRES

47. Samples of air should be taken from the sealed area and chemically analyzed. Opening should not be attempted for at least one hundred (100) days.
48. It indicates an active or recently active fire.
49. Carbon monoxide.
50. When the oxygen is reduced to twelve percent (12%).
51. Sufficient time should be allowed for the area to cool to minimize the danger for rekindling. (one hundred days minimum).
52. One percent (1%), or lower.
53. Dilution with pure air is likely to form an explosive mixture, a low percentage of oxygen will lessen the danger.
54. Gradually and systematically unless conditions make this method too hazardous.
55. To be assured that all places are cleared of gas before men enter and to prevent explosive mixtures from forming by an increase of oxygen.
56. Practically none.
57. Preparation should be made for the fire gases to pass directly to the main return and all entries outby the seals should be heavily rock dusted.
58. The dangerous character of the gases makes the operation extremely hazardous.
59. The composition of the fire gases as found by chemical analysis and their correct interpretation.
60. The oxygen will be reduced faster in the presence of a raging fire.
61. Heat will be retained longer and the danger of rekindling will be increased.
62. The difference in pressure may create an air leakage across the fire area.
63. Variations of pressure will result in air leakage around the fire seals in the direction of the lower pressure.
64. When the affected area is small and there is every indication that the fire has been extinguished.
65. When the sealed area is extensive and it is uncertain whether or not the fire has been extinguished.
66. By advancing into the area by means of air locks.
67. Apparatus crews advance short distances inside of air locks and after erecting new seals with provisions for air locking, ventilation is re-established to the new base and this procedure is repeated.
68. Crews wearing self-contained oxygen breathing apparatus break the seal on the intake side, behind a previously constructed air lock, and after exploring the affected area, the return seal is broken and the area reventilated.
69. Electricity should be cut off the entire mine.

ANSWER SHEET FOR
EXPLOSIONS AND RECOVERY

70. Ignition of gas or coal dust, or both, by electric arcs, blown-out shots and smoking.
71. Accumulation of explosive mixtures of methane.
72. Interrupted ventilation.
73. Short circuiting of the ventilating current for example by leaving doors open, tearing line curtain down, and knocking out stoppings.
74. Electric arcs.
75. By adequate ventilation, use of rock dust, and the safeguard use of electricity and close supervision and frequent examinations for methane.
76. By removing of excessive coal dust and rock dusting.
77. See that the ventilating fan is operating properly.
78. Pull and lock out all electrical switches leading into the mine.
79. Endeavor to ascertain their names and possible locations.
80. Rope off an area around the entrance and admit none except authorized persons.
81. To furnish an up-to-date map of the mine showing the regular coursing of the air, and keep it posted to show progress of recovery.
82. The director and the district mine inspector.
83. One (1) only.
84. Men with experience and special training in recovery operations.
85. At least two (2).
86. All men should be properly check and searched.
87. All –service gas mask crews, trained oxygen breathing apparatus crews, and fresh air labor crews to build stoppings, carry material and stretchers.
88. They should be well trained, physically fit, and competent.
89. Respiratory apparatus crews should have self-contained oxygen breathing apparatus or all-service gas masks, and all men should have self-rescuers.
90. Carbon monoxide detectors.
91. Brattice cloth, boards, brick, tile, cement, copper hammers and other hand tools.
92. Anemometer.
93. Oxygen inhalators, first-aid supplies, stretchers and blankets.
94. Fire extinguishers of proper type and rock dust.
95. Near the fresh-air base.
96. Examine return airways for smoke or indications of fire.
97. Dormant fires may be revived and an explosion may follow.
98. The fresh-air base must be in fresh air, free from possible contamination by poisonous and explosive gases, secure against roof falls, and readily accessible for rescue and recovery operations.
99. Self-contained oxygen breathing apparatus of all-service gas masks.
100. Where the carbon monoxide content exceeds two percent (2%).
101. Where the carbon monoxide content exceeds two percent (2%).

ANSWER SHEET FOR
MINE RESCUE TEAMS

102. The percentages between the lower explosive limit and the maximum explosive point-five percent (5%) to ten percent (10%).
103. The percentages between the maximum explosive point and the upper explosive limit ten percent (10%) to fifteen percent(15%).
104. He should have all apparatus examined and have a thorough understanding with the man in charge as to the extent and duration of the trip, and see that another crew is in reserve.
105. They should carefully examine all parts of area assigned for inspection, marking direction arrows back to fresh-air base and end of travel with chalk, by date and name of crew.
106. About six (6) feet apart.
107. With a life-line or communication system.
108. About three hundred (300) feet.
109. One thousand (1,000) feet one way.
110. One thousand (1,000) feet.
111. One (1) pull.
112. Two (2) pulls.
113. Three (3) pulls.
114. Taut between all members and base.
115. Only to save lives or in an emergency.
116. When an explosion is probable.
117. When necessary to crawl or in deep water.
118. When temperature is high.
119. When apparatus is inadequately charged or in an unsafe condition.
120. When only extremely short trips are necessary, and then only to save life or do extremely important work necessary to recovery operations.
121. They should be given first-aid treatment at the fresh-air base and permitted to partially recuperate before being accompanied outside.
122. Because of the severe physical reaction caused by the outside atmosphere.
123. Wood and brattice cloth, boards, plaster and plastic.
124. Every effort should be made to extinguish them, if possible, if fire is inaccessible it should be sealed at once.
125. To expedite the transmission of messages and instructions.
126. So that rescue and recovery work can be systematically planned and executed.
127. At the fresh-air base.
128. Men should be checked out of the mine.
129. That dangerous gases are not permitted to issue from adjoining open dead ends or unventilated areas.
130. They should be swept free from dangerous gases or temporarily sealed.
131. Carbon monoxide.
132. A stopping erected to prevent gases from an explosion reaching an unaffected portion of the mine where men may remain safely until rescued.
133. Yes, in many cases.
134. From any suitable material at hand such as gob, stopping material, ties taken from track, brattice cloth or used lumber.
135. Short circuit the ventilation from the section and erect a barricade.

136. By short-circuiting the air at least fifty (50) feet outby the place and erecting a temporary curtain.
137. As large as possible.
138. He should remain quiet, occasionally moving about to mix the air.
139. They should be extinguished. They deplete oxygen and may cause an explosion.
140. It can be used to replenish the air.
141. About one (1) cubic yard per hour.
142. Approximately thirty-seven (37) hours.
Solution: $\frac{100 \times 10 \times 5}{27} = \frac{5000}{27} = 185 \quad \frac{185}{5} = 37$hours.
143. If the place is large enough additional barricades can be built inby the first ones erected, or the crevices can be plugged.

ANSWER SHEET FOR MINE RESCUE

1.	b	6.	c
2.	b	7.	a
3.	b	8.	b
4.	b	9.	b
5.	d	10.	d

ANSWER SHEET FOR FIRES & EXPLOSIONS

1.	c	6.	a
2.	c	7.	a
3.	c	8.	a
4.	b	9.	c
5.	b	10.	b

CHAPTER EIGHT

BREATHING APPARATUS

1. 2-Hour McCaa
2. 3/4-Hour Chemox
3. 1-Hour M.S.A. W-65 Self-Rescuer

McCAA 2-HOUR OXYGEN BREATHING APPARATUS

1. What is the pressure in a fully charged McCAA 2-hour apparatus oxygen bottle?
2. How much oxygen does a fully charged oxygen bottle contain?
3. Why is it necessary to have a pressure gage?
4. How would you remove moisture from the oxygen bottle?
5. How would you test the oxygen bottle and the main and bypass valves for leakage?
6. Why is a safety cap attached to the bottle valve?
7. Why does a metal tube project from the end of the bottle valve into the oxygen bottle?
8. Why is the apparatus equipped with a bypass valve?
9. Why is the bypass valve not kept open?
10. When the bypass valve is opened does the oxygen have a free, open course to the wearer's lungs?
11. Is it a good policy not to use the bypass valve when the reducing and admission valves are supplying the wearer with enough oxygen?
12. Why should there be a lock on the main bottle valve wheel?
13. How many turns should the main bottle valve be opened?
14. What is the function of the reducing valve?
15. How would you test the shutoff and flow pressure of the reducing valve?
16. Why is a locknut used on the rod connecting the bellows to the lever-arm joint of the reducing valve?
17. How would you know when to have the reducing valve repaired?
18. What is the admission valve, and how is it operated?
19. How would you test the admission valve?
20. How would you test the safety valve to determine whether it will operate?

21. At what pressure will the safety valve whistle and release the excessive pressure of the reducing valve?

22. Why will the pressure against the safety valve not increase beyond the blow-off point?

23. Why is the safety valve made so that it will whistle?

24. What would you do if the safety valve started to whistle while you were wearing the apparatus?
25. Where does the high and the intermediate oxygen pressure end?

26. When the bottle valve is closed and no pressure is in the high and intermediate pressure side of the apparatus are the admission and reducing valves opened or closed?

27. What makes the admission and reducing valves close?

28. What would you do if the pressure gage tube or gage developed a leak or broke?

29. Why is the apparatus equipped with a cooler?

30. How would you test the metal tube in the cooler for leaks?

31. Why are the cooler and regenerator made in one piece?

32. Why is the apparatus equipped with a breathing bag?

33. What is the air capacity of the breathing bag?

34. How would you test for leaks in all oxygen connections from the main bottle valve to the admission valve seat?

35. Why are flexible corrugated rubber tubes attached to the mouthpiece or face piece?

36. What valves are in the metal housing attached to the mouthpiece and face piece?

37. Why are the inhalation and exhalation valves placed so close to the wearer's mouth?

38. Why is the breathing apparatus equipped with inhalation and exhalation valves?

CHEMOX 3/4-HOUR
OXYGEN-GENERATING APPARATUS

39. Why is a 3/4-hour apparatus not recommended for use in rescue and recovery work in mines except as auxiliary apparatus?

40. How does the Chemox apparatus differ from other self-contained breathing apparatus?

41. How is oxygen generated and exhaled carbon dioxide removed in the canister?

42. What is the service life of the canister?

43. Why is it necessary to have a timer on the apparatus?

44. What is the purpose of the plunger assembly?

45. Why is the apparatus equipped with a breathing bag?

46. What is the purpose of the rubber tubes in the breathing bag?

47. Why are flexible corrugated rubber tubes attached to the face pieces?

48. What valves are in the metal valve housing of the face piece?

49. Why is the apparatus equipped with inhalation and exhalation valves?

50. What is the purpose of the pressure release valve?

51. Why is a check valve used with the pressure release valve?

52. What is the purpose of the built in ducts in the face piece?

53. How would you insert a canister in the apparatus?

54. How would you start chemical reaction in the canister?

55. What precautions would you take in storing the Chemox apparatus and canisters?

56. How would you test the complete apparatus for air tightness?

57. What are the objectives of testing the Chemox apparatus?

58. How does air circulate through the Chemox apparatus?

59. What governs the rate of oxygen liberation in the canister?

60. Why does excess pressure build up in the circulatory system?

61. What indicates excessive pressure in the apparatus?

62. How would you release excessive pressure from the apparatus?

63. Is it necessary to purge nitrogen from the Chemox apparatus?

64. When and how would you set the timer on the apparatus?

65. Why is the timer provided with a bell?

66. In addition to the timer, what other indications are there that the canister is approaching the end of its service life?

67. Should a canister be reused if it has not been used for its entire 45-minute service life?

68. How would you recover a canister from the apparatus?

69. What precautions would you take in handling a canister?

70. How would you dispose of the canister?

71. How long may an unopened canister be stored before use?

72. Why should a crew wearing Chemox apparatus after entering an irrespirable atmosphere proceed slowly or stop near the fresh air base for a short time?

73. Why is there a release valve in the metal valve housing of the mouthpiece of face piece?

74. Why is there an inhalation check valve in the saliva trap or release valve?

75. How would you test the mouthpiece?

76. Why is the outside flap of the rubber mouthpiece cut and straps attached to fit as they do?

77. How would you test the face piece?

78. What percentage of carbon dioxide is given off in exhalation?

79. What chemical material is used to absorb carbon dioxide?

80. How many pounds of cardoxide does a fully charged apparatus contain?

81. How would you empty the apparatus and charge it with cardoxide?

82. Why can intermittent work be done without building up resistance to breathing in the cardoxide?

83. Why does the exhaled air not channel through the chemical used for absorbing carbon dioxide?

84. How would you sterilize the mouthpiece or face piece and tubes?

85. How does the air circulate through the McCAA 2-hour apparatus?

86. What are the two main objectives of testing the apparatus?

87. Why is it necessary to examine apparatus connections?

88. How would you test the air-circulating system for resistance?

89. What is the pressure in the air circulating system when the admission valve opens to admit oxygen?

90. How would you test the complete apparatus for air tightness?

91. How would you remove excessive nitrogen from the air circulating system?

92. How often would you use the release valve to avoid accumulations of nitrogen?

93. What is the maximum exhalation resistance in the apparatus?

94. When is an apparatus in proper condition for use?

95. Why should a rescue crew, after entering a deadly atmosphere, proceed slowly or stop near the fresh air base for a short time?

96. Suppose in an emergency a member of your crew was out of oxygen and you had at least 60 atmospheres, what would you do?

97. What is a self contained oxygen breathing apparatus?

98. What is the general principle of the McCAA oxygen apparatus?

99. How does one breathe in a self contained oxygen apparatus?

100. What is the function of the regenerator of a self contained McCAA oxygen breathing apparatus?

101. What is the chemical used in a self contained oxygen apparatus to absorb carbon dioxide?

102. Where is oxygen admitted to the circulatory system of a McCAA self contained oxygen breathing apparatus?

103. What is the purpose of admitting oxygen to the breathing bag of a self contained oxygen breathing apparatus?

104. What is the source of the inhaled air in a self contained oxygen apparatus?

105. What is the course of the exhaled air in a self contained oxygen apparatus?

106. Into what does the air pass, on leaving the cardoxide container (regenerator) of a self contained oxygen breathing apparatus?

107. What is the purpose of the pressure gauge on a self contained oxygen breathing apparatus?

108. What is the function of the reducing valve of a self contained oxygen breathing apparatus?

109. How is excess air released from the circulatory system of a self contained oxygen breathing apparatus?

110. What is the purpose of the bypass valve of a self contained oxygen breathing apparatus?

111. What is the effect of an excess of nitrogen in the circulation system of a self contained oxygen breathing apparatus?

112. What are the chief qualifications for a wearer of a self contained oxygen breathing apparatus?

113. How may an excess of nitrogen be removed from a McCAA self contained oxygen breathing apparatus?

WHAT IS THE SELF-RESCUER?

The self-rescuer is a small gas respirator designed to protect the wearer from carbon monoxide present in the air following a fire or an explosion.

It is small enough so that it may be carried on ones belt or machine and thus be readily available in case of an emergency.

The self-rescuer should be used immediately at the first indication of a fire or explosion even if no smoke is visible. Waiting until smoke is visible may prove fatal. Carbon monoxide is colorless and odorless and could build up to a dangerous concentration before there is any sign of smoke.

The self-rescuer contains a catalyst (hopcalite) which changes carbon monoxide, a poisonous gas, to carbon dioxide a relatively harmless gas.

It also contains a during agent which prolongs the usefulness of the hopcalite and a heat exchanger which reduces heat build up produced by chemical reaction of carbon monoxide with hopcalite.

The self-rescuer should be used only against carbon monoxide. It is not a substitute for conventional respiratory equipment, such as gas masks or self-contained breathing apparatus. As the name implies the self-rescuer is intended to help the wearer escape from an atmosphere polluted with carbon

monoxide. It will not proved protection in an atmosphere where there is not enough oxygen, (less than 16 percent of oxygen).

According to tests conducted by the U.S. Bureau of Mines, w-65 self-rescuers provided adequate protection for 60 minutes in one percent concentration of carbon monoxide. These tests also revealed that at two percent carbon monoxide concentrations, the heat generated by the chemical reaction of the hopcalite was almost unbearable to the wearer. If you are even confronted with such a situation, you must keep the self –rescuer in place regardless of the heat generation. To remove a self-rescuer under such circumstances will result in instant death.

The self-rescuer should be used only for the purpose of escape or self-rescue from atmospheres containing carbon monoxide. It is not to be used as a substitute for conventional respiratory equipment, such as gas masks or self contained breathing apparatus. As the name implies, the self-rescuer is intended for use in assisting you to escape from an atmosphere contaminated with carbon monoxide. The primary function of a self-rescuer is to give you protection against carbon monoxide. It will not provide protection against other gases, or atmospheres in which there is less than 16 percent of oxygen.

The self-rescuer might also be referred to as a single use unit that cannot be reused. Once the seal on the self-rescuer has been broken, this device must be used immediately and then discarded. The shelf life of the self-rescuer on a belt or machine has been approved for five years.

The W-65 self-rescuer is used in the following manner:

1. Open self-rescuer by firmly pulling the lever up to break canister seal
2. Remove cover and discard
3. Remove from container
4. Grip rubber tips of mouthpiece firmly between teeth, making an airtight seal with lips around mouthpiece
5. Close nostrils with the nose clip
6. Place headstrap on head
7. Replace hat
8. Breathe only through rescuer
9. Go to fresh air immediately

Before going underground every miner should examine his self-rescuer for any external damage.

Should the container of the self-rescuer be dented, it may be impossible in cases of emergency to remove the respirator from the container. In this case the wearer can still breathe even with the filter being held in the container. The space between the filter and the inner wall of the container is sufficient to allow normal breathing.

The self-rescuer unit should be periodically checked for air-tightness by immersing in warm water and looking for escaping air bubbles as you would check an inner tube for a leak.

ANSWER SHEET FOR
McCAA 2-HOUR OXYGEN BREATHING APPARATUS

1. A pressure of 13.5 atmospheres or 1,984.5 pounds a square inch.
2. The volume of the oxygen bottle is 110 to 116 cubic inches, equivalent to 1.8 to 1.9 liters or approximately 2 quarts. When charged to a pressure of 135 atmospheres, the bottle holds 8.6 cubic feet or about 243 liters of oxygen.
3. To indicate the pressure in the oxygen bottle.
4. Hold the bottle with the main valve down, open and quickly close the main valve, exhausting the moisture, If the bottle contains considerable moisture, release all oxygen from the bottle, remove the valves, and drain and clean the bottle thoroughly.
5. Place a metal cap on the outlet of the main bottle valve, open the main valve, and immerse the valve and bottle in water. Then close the main bottle valve, remove the cap, and again immerse the outlet of the main valve in water. Escaping oxygen bubbles during tests indicate leaks. Test the bypass valve in the same manner.
6. It is required by the Interstate Commerce Commission to provide for the escape of oxygen without rupture of the bottle during exposure to fire. The cap contains Rose's metal, which melts at 94^{o} C, and a frangible copper disk, which will rupture if the pressure is increased beyond the safety factor of the material. The design of the cap, with Rose's metal against the copper disk, increases the safety factor by preventing the disk from rupturing unless heat is applied; if heat is applied, the Rose's metal will melt, and the copper disk will rupture at the desired safety factor.
7. To obtain oxygen free from sediment.
8. So the wearer can obtain oxygen if any part of the oxygen-supply system fails to operate properly.
9. Because the pressure is too great for the strength of the material used in the construction of the apparatus. The wearer could not inhale or exhale under this pressure without endangering his health.
10. When they bypass valve is opened the oxygen has a free course to the lungs, as all openings are large and only the inhalation valve is between the bypass valve and the lungs; moreover, the inhalation valve opens toward the lungs.
11. The bypass valve should not be used when the reducing and admission valve are supplying enough oxygen as pressure is developed against exhalation and is liable to cause distress and excite the wearer.
12. A lock avoids the closing of the valve through mistake or accident.
13. The main bottle valve should be opened fully.
14. Reduces high pressure to low pressure.
15. Attach a low-pressure gage to the outlet end of the reducing valve and to the oxygen supply tube, open the main bottle valve, and with the admission valve closed, observe the shut-off pressure indicated: This should be approximately 3 pounds. Then with the low pressure gage valve and the admission valve open, note the flow pressure; this should be between ½ and 1 pound
16. To keep the reducing valve in proper working condition as set by the manufacturer.
17. When the safety valve whistles, when no oxygen is supplied to the wearer, or when insufficient or excessive pressure is indicated by the testing gage.
18. The admission valve admits fresh oxygen under breathable pressure into the air circulation system of the apparatus; it is opened by the bumper plate on the breathing bag when the bag is deflated or emptied on inhalation, and it is closed by a spring when the breathing bag is inflated sufficiently to draw the bumper plate away from the admission valve stem.

19. Open the main bottle valve, holding the admission valve plate outward so that the admission valve is closed; then close the main bottle valve, and open and close the admission valve, observing he pressure-gage hand moving and stopping as the pressure is reduced.
20. Increase the pressure in the reducing valve by compressing the bellows when the main bottle valve is open and the admission valve closed; this increases the pressure so that the safety valve will blow off and whistle.
21. The safety valve should operate at approximately 7 pounds above atmospheric pressure.
22. Because increased pressure opens the valve fully and allows oxygen to escape rapidly.
23. To warn the wearer that there is too much pressure in the reducing valve.
24. Close the main bottle valve and use the bypass valve by opening and closing it momentarily until fresh air is reached.
25. The high oxygen pressure ends at the end of the reducing valve nozzle, and the intermediate pressure ends at the seat of the admission valve.
26. The admission and reducing valves are opened when the main bottle valve is closed and no pressure is in the high and intermediate pressure sides of the apparatus.
27. As the pressure builds up in the circulatory system the breathing bag expands, drawing the bumper plate away from the admission valve stem, thus permitting the valve to close. When the admission valve is closed, the oxygen pressure below the seat of the admission valve increases so that the bellows of the reducing valve extends, thereby moving the lever arm and forcing the seat of the reducing valve over the orifice of the nozzle and cutting off the high pressure of the oxygen bottle at this point.
28. Close the pressure gage valve, and return to fresh air.
29. To cool the circulating air and form a frame to which other parts of the apparatus are attached.
30. Determine first whether all other parts are airtight; then close the admission valve, open the main bottle valve, and read the pressure gage; then close the main bottle valve. Any leaks in the tube will show on the gage.
31. So that the apparatus can be made more rigid by avoiding the space allowed for disconnecting, and so there will be fewer gaskets to keep tight.
32. It acts as an air reservoir and reduces resistance to breathing.
33. It is about 8 liters or approximately 8 quarts.
34. Draw out the plate of the breathing bag so that the admission valve is close; next, turn on the main bottle valve; not the pressure gage reading; and close the main bottle valve. If there are any leaks, the gage hand will move toward zero; locate leaks by brushing the joints with soapsuds.
35. The tubes allow free movement of the wearer's head and do not interfere with circulation of air in the apparatus.
36. There are four valves in the metal housing inhalation, exhalation, salivatrap or fixed mica disk check, and release valve.
37. To reduce the dead air space.
38. These valves force the air to circulate in one direction, so a Chemox crew entering a deadly atmosphere should proceed slowly or stop near the fresh air base for a short time so that if any apparatus leaks or fails to work properly or if a team member is sick or is not qualified to proceed on the trip, the crew can return to fresh air quickly without undue hazard.

ANSWER SHEET FOR
CHEMOX 3/4 HOUR OXYGEN GENERATING APPARATUS

39. A 3/4-hour supply of oxygen will permit a wearer to travel only a short distance in an irrespirable or poisonous atmosphere. Mine rescue crews are trained always to have a 1/2 hour reserve supply of oxygen when returning to a fresh air base and not to enter a noxious atmosphere for the purpose of exploring or working with less than a 1/2 hour supply of oxygen. Therefore, because of its limited oxygen supply, the 3/4 hour apparatus is not recommended, except as auxiliary equipment, for rescue and recovery work in mines.
40. The Chemox apparatus has no high pressure cylinder, reducing valve, or admission valve, and uses a replaceable chemical canister to supply the wearer with oxygen and to remove carbon dioxide from the exhaled breath.
41. By the reaction of moister in the exhaled breath on the chemical potassium superoxide, and carbon dioxide is retained by simultaneous chemical reaction.
42. The canister will supply the wearer with enough oxygen for 45 minutes of hard work.
43. The timer indicates the length of time the canister has been in service.
44. The plunger assembly breaks the seal of the canister against the plunger housing, conduct the exhales air into the canister, and conducts the oxygen generated to the breathing bag.
45. It acts as a flexible lung and as a reservoir and cooler for oxygen evolved in the canister.
46. They cause the oxygen to flow across the entire area of the bag to obtain maximum cooling.
47. They allow free movement of the wearer's head and do not interfere with the circulation of air in the apparatus.
48. There are four valves in the metal valve housing inhalation, exhalation pressure release valves, and a check valve used in conjunction with the pressure release valve.
49. These valves force the air to circulate in one direction so that it will be purified and replenish with oxygen.
50. It permits the wearer to release excess pressure that may build up in the apparatus.
51. It prevents the wearer from inhaling outside air when the pressure release valve is open.
52. They direct the oxygen across the inner surfaces of the lenses to prevent fogging.
53. Put on the apparatus but not the face piece; remove the metal tear off cap and the metal and cardboard disks from the canister, exposing the copper foil seal, swing the bail of the canister frame outward, and insert the canister with the smooth side to the front into the canister frame sufficiently to break the copper foil seal; then swing the bail back to its proper position, and turn the hand wheel clockwise until the canister gasket is snug against the plunger housing.
54. Put on and adjust the face piece, then squeeze both breathing tubes with one hand, break the seal of the face piece against the cheek with a finger and inhale, then release the breathing tubes and exhale into the apparatus. Repeat this procedure until the breathing bag is inflated fully. Depress the pressure release valve and force the air from the breathing bag with the forearms. Re-inflate the breathing bag by repeating the starting procedure.
55. They should be stored and started at temperatures above 32^{o} F. If the apparatus and canisters are stored in temperatures below 32^{o} F., the moisture in the breath will condense in them making starting difficult or impossible.
56. Grasp the lower end of the inhalation tube, squeeze it tightly, and inhale. If the face piece collapses, the face piece seal is sufficiently tight, the exhalation valve closes properly, and the upper part of the inhalation tube and the metal valve housing are free from leaks. Continue to squeeze the inhalation tube, depress the pressure release valve button and inhale. If the face piece collapses, the check valve used in conjunction with the release valve is functioning

properly. Release the inhalation tube and squeeze the lower end of the exhalation tube. Inhale, and then exhale forcibly. If the exhales air is forced out between the face and face piece only the inhalation valve closes properly, and the upper end of the exhalation tube is free of leaks. Finally, with the breathing bag will inflate, grasp and close the upper ends of the breathing tubes and depress both sides of the breathing bag with the forearms. If the bag does not deflate, the apparatus is tight. Leaks may be found by brushing soapsuds on the parts under pressure.

57. To determine air tightness and functioning of working parts.
58. The exhaled breath passes from the face piece through the exhalation valve and tube, the plunger tube, and the vertical tube in the canister into the airspace at the bottom of the canister. The breath then expands and passes through the chemical. Here the moisture in the breath activates the chemical, which liberates oxygen flows through the plunger housing and through a rubber tube into the bottom of the right side of the breathing bag. After filling the right side of the breathing bag, the oxygen passes across the top of the bag into the left side, then enters the rubber tube in the left side of the bag, and flows through the inhalation tube and valve to the face piece.
59. The breathing rate of the wearer.
60. Once the chemical in the canister is activated, oxygen is liberated faster than it is consumed and builds up excessive pressure in the circulatory system.
61. Oxygen escaping around the face piece and the high resistance on exhalation.
62. Depress the pressure release valve button and partly deflate the breathing bag with the forearms.
63. Excess oxygen escaping around the face piece and excess pressure released through the pressure release valve simultaneously purge nitrogen that may be present in the apparatus.
64. Set the timer before wearing the apparatus in an irrespirable atmosphere and allow enough time for return to fresh air from the place work is to be done or form the farthest point of travel. For example, if it will take 10 minutes to return to fresh air, deduct 10 minutes from 45 minutes and turn the pointer of the timer clockwise to 34, if on an exploration trip allow approximately half the service life of the canister for each direction of travel. Return to fresh air when the bell on the timer rings.
65. The timer is provided with a bell to warn the wearer that the end of the interval timed has expired if he should fail to note the time on the dial visually.
66. The fogging of the face piece lenses during inhalation and high resistance on exhalation which cannot be alleviated by use of the release valve, indicate that the canister is approaching the end of its service life.
67. Once a canister is opened it should not be reused, since its service life is not certain.
68. Turn the hand-wheel down, swing the bail outward, and remove the canister with the hand suitable protected by a glove or other covering as the canister may be hot.
69. Never allow any substance to enter the neck of the canister. Especially oil, water, and oil gasoline, grease, etc. as the chemical contains oxygen, which will bring about combustion of any flammable material with which it is brought into direct contact, especially if such materials are moist.
70. Remove it to the surface if used underground, punch a small hole in the front, back, and bottom, and place it in a bucket of clean water deep enough to cover the canister at least 3 inches. When bubbling stops any residual water which is caustic, down a drain or dispose of it in any other suitable manner and then discard the canister. Do not puncture a canister underground because friction from a metal piercing tool or nail in the presence of oxygen and coal dust can ignite the coal dust.
71. It may be stored indefinitely, as it will not deteriorate in proper storage.
72. That it will be purified and cooled and fresh oxygen will be supplied as required by the wearer.

73. To permit the wearer to release excess pressure, clear the apparatus of nitrogen, and discharge accumulated moisture to the outside.
74. To prevent the wearer from inhaling the outside atmosphere when the release valve is open.
75. Close the opening of the inhalation tube coupling with the palm of a hand or a solid plug and inhale through the mouthpiece; if inhaling is impossible the exhalation valve and the inhalation tube are free of leaks. Next close the opening of the exhalation tube coupling and exhale through the mouthpiece; if exhaling is impossible, the inhalation valve, the release valve, and the exhalation tube are free of leaks. Inhale and exhale through the mouthpiece several times and observe whether the inhalation and exhalation valves open and close freely. Test the valve in the saliva trap by closing the end of the inhalation tube, then open the release valve and inhale through the mouthpiece; if inhaling is impossible the saliva trap is free of leaks. To locate leaks, plug the openings of the mouthpiece and the exhalation tube, immerse all parts except the end of the inhalation tube in water, and exhale into the inhalation tube. Air bubbles indicate leaks.
76. They are cut so that the rubber flap seal will draw tightly over the outer surface of the mouth when the straps are adjusted, making a tight external seal.
77. Put the face piece on and adjust it snugly to the face; then close the opening of the inhalation tube coupling, open the release valve and inhale. If the face piece collapses against the face and inhaling is impossible, the exhalation valve and the fixed check valve in the release valve housing close properly and the face piece, valve hosing, and inhalation tube are free of leaks. Next close the opening of the exhalation tube coupling and exhale; if air escapes only around the edges of the face piece, the inhalation valve, the release valve and the exhalation tube are free of leaks. Inhale and exhale in the face piece several times and observe whether the inhalation and exhalation valves are open and close freely. Exhale forcibly into the exhalation tube is impossible air does not pass between the exhalation valve insert and the wall of the valve housing.
78. Approximately 2.6 to 6.6 percent carbon dioxide is given off in exhalation.
79. Cardoxide is used to absorb carbon dioxide.
80. A fully charged apparatus contains 4 pounds of cardoxide.
81. Remove the metal cap on the end of the regenerator, pour out the used cardoxide, and refill with 4 pounds of fresh cardoxide.
82. The chemical used for absorbing carbon dioxide does not change form therefore, it does not block the air course or build up resistance to breathing.
83. The exhaled air fills the space below the cardoxide and, meeting an equal resistance through the chemical, flows uniformly thus preventing the short circuiting of exhaled air.
84. By placing them in a sterilizing solution made with disinfectants, such a hypochlorite, bichloride of mercury, or Lysol; then wash well in clear water.
85. Oxygen from the bottle passes through the main bottle valve into the reducing valve through a rubber oxygen supply tube and a metal tube enclosed in the cooler and through the admission valve, discharging into the breathing bag. It then passes through openings around the admission valve into the mouth piece or face piece and into the lungs. Exhaled air containing carbon dioxide and unused oxygen passes through the exhalation valve and tubes into the regenerator and through the regenerator into the cooler and breathing bag to repeat the cycle, fresh oxygen being supplied from the bottle through the reducing and admission valves as required. The bypass valve supplies oxygen from the bottle to the wearer independently of the main bottle, reducing, safety, and admission valves.
86. To determine the air-tightness and to check functioning of working parts.
87. To see whether all gaskets are in place and the connections are air tight.

88. Blow into the long exhalation tube opening holding the hand 1 inch away from the inhalation tube opening, and feel air blowing on the hand; forced breathing indicates resistance.
89. Approximately 1/4 inch of positive water gage pressure is in the air circulating system.
90. Close the admission valve by raising the breathing bag and open the main bottle valve; then, with the gage valve open, read the high pressure gage and close the main bottle valve. If the hand of the high pressure gage remains stationary, the high and Intermediate pressure side of the apparatus is air tight. If a mouthpiece is used with the apparatus, exhale repeatedly into the mouthpiece to inflate the breathing bag, slip the mouthpiece out of the mouth, and quickly block the mouthpiece opening with thumb or inflate the breathing bag by blocking the mouthpiece opening and opening the bypass valve momentarily. If a face piece is used with the apparatus put on and adjust the face piece snugly to the face. With one hand crimp and close the corrugated inhalation tube near the face piece, insert the fingers on the other hand between the face and face piece, and inhale air from the outside; then remove the fingers from between the face and the face piece and exhale into the apparatus. Repeat this procedure until the breathing bag is inflated. The breathing bag may be inflated by crimping and closing the corrugated inhalation tube and opening the bypass valve momentarily. With the corrugated inhalation tube closed press on the breathing bag, and if it remains inflated the low pressure side of the apparatus is airtight.
91. If a face piece is used turn on the main bottle valve put on and adjust the face piece then turn off the bottle valve inhale from the apparatus and exhale through the release valve a sufficient number of times to evacuate the apparatus and exhale through the release valve at least three times.
92. Open the release valve and exhale into the outside air 3 or 4 times every 15 to 20 minutes.
93. Approximately 1-1/2 inches of water gage.
94. When the apparatus parts made of adequate material are assembled properly, when the apparatus is fully charged and airtight, and when all parts are functioning perfectly, the apparatus is in proper condition for use.
95. A rescue crew entering a poisonous atmosphere should proceed slowly or stop near the fresh air base for a short time so that if any apparatus leaks or fails to work properly, or if a team member is sick or not qualified to proceed on the trip, the crew can return to fresh air quickly without undue hazard.
96. If a member of a crew exhausts his oxygen supply, remove him to fresh air as quickly as possible. If the fresh air base cannot be reached quickly and if there are at least 6 atmospheres of oxygen in the bottle of another crew member, close the pressure gage valve and remove the gage from the apparatus with the empty bottle. Remove the bypass tube from the outlet of the bypass valve and then open the gage valve and bypass valve end equalize the pressure in the bottles. Close the gage and bypass valves remove the gage tube from the bypass valve outlet, and reassemble the disconnected parts. A simpler and much safer method of equalizing the pressure in two bottles if necessary is to use a coupling commonly called a buddy connection, with threaded ends that fir the coupling nut on the gage end of the pressure gage tube. If a buddy connection is carried by the crew, close the pressure gage valves on both apparatus remove the gages, connect the gage tubes to the buddy connection, then open the pressure gage valves and equalize the pressure in the two bottles. After equaling the pressure in the bottles close the gage valves, remove the buddy connection and replace the gages.
97. A device to protect the wearer against any concentration of poisonous mine gases or oxygen deficiency.
98. Oxygen is supplied to the wearer and exhaled carbon dioxide is absorbed.
99. Inhalation and exhalation are made through a face piece.

100. To absorb carbon dioxide from the exhaled air.
101. Cardoxide.
102. Through the reducing valve and the admission valve into the breathing bag.
103. To replenish the supply of oxygen and cool it.
104. From the breathing bag and cooler.
105. It passes through a tube to the cardoxide container (regenerator).
106. Into the cooler and breathing bag.
107. To indicate the pressure of oxygen in the oxygen cylinder.
108. To reduce the pressure of oxygen so it can be safely admitted to the apparatus.
109. By the release valve.
110. To supply oxygen in case of failure of normal working parts.
111. The oxygen content is reduced.
112. He shall be physically fit and properly trained.
113. By inhaling from the apparatus and exhaling to the outside through the pressure relief valve, while holding a kink in the exhalation tube.

CAPTER NINE

INSTRUMENTS

1. Barometer
2. Water Gauge
3. Thermometer
4. Anemometer
5. M.S.A. Methanometer
6. National Mine Service G-70
7. M.S.A. Methane Spotter
8. Bacharach Canary
9. M.S.A. Colorimetric Carbon Monoxide Detector
10. Bacharach Carbon Monoxide Indicator
11. Bacharach Carbon Dioxide Indicator
12. Monoxor Carbon monoxide Detector (pencil type)
13. M.S.A. Hydrogen Sulphide Detector
14. Nitrogen Dioxide Detector

BAROMETER

A barometer is an instrument used to measure the pressure of the atmosphere. The use of the barometer is a practical advantage, in the operation of a mine, by showing the change in the atmospheric pressure as they occur. A careful study of these changes in pressure in connection with the gaseous condition of the mine workings, enables a more intelligent arrangement and control of the ventilation , and will often forecast a dangerous gaseous condition existing in the mine, owing to a rapid fall of the barometer.

Regular barometer reading, in connection with mining operations, are important in respect to their indicating the expansive effect produced on a sudden fall of the barometer or decrease of atmospheric pressure, As a result of this, the air and gases confined in a large abandoned area are forced out into the live workings, causing the explosive condition of the mine air to be considerably increased for a time.

MINE WATER GAUGE

A water gauge consists of a glass u tube partially filled with water open at both ends and is graduated in inches and tenths thereof.

A water gauge is used in Mine Ventilation, for the purpose of computing the power on the air. It should, therefore, be placed on the fan drift, in order that it shall take into account the entire resistance of the shaft and mine, which the ventilating fan must overcome. In this position of the water gauge its reading indicates the pressure established by the fan, which is above or below the atmospheric pressure, according as the fan is blowing air into or exhausting air from the mine. The rise of fall of one inch difference in the level of the water column denotes 5.2 lbs. per square feet.

Example: If the water gauge suddenly shows a rise of half an inch, without having increased the speed of the fan, what would you understand from this and what would be your movements?

Assuming the fan is running at the same speed and the water gauge is observed to take a sudden rise of half an inch, it is natural to suppose that the increased gauge is due to a greater mine resistance, which is probably caused by some undue obstruction of the air current. This will call for an immediate investigation to ascertain the cause. It may be that a heavy fall of roof has blocked the airway at some point in the mine; or the obstruction may be caused by the movement of a particularly heavily loaded trip against the air.

The sum of the difference of the two water levels as shown on the scale is the water gauge reading.

THERMOMETER

An instrument for determining temperature, and used to measure temperatures of sealed area and to determine the relative humidity of mine air.

Regular readings of the thermometer taken inside and outside of the mine are important as showing a greater or less capacity of the air for carrying moisture or absorbing moisture from the mine. Hygrometer reading are of greatest value in a dry and dusty mine.

ANEMOMETER

The form of Anemometer generally used in coal mining consists of a metal ring within which is set a rotating propeller of blade. The air current striking the inclined blades rotates the bane, the number of revolutions being recorded on the face of the dial by means of a series of gears. The instrument is employed to measure the velocity of the air current in mine airways as expressed in feet.

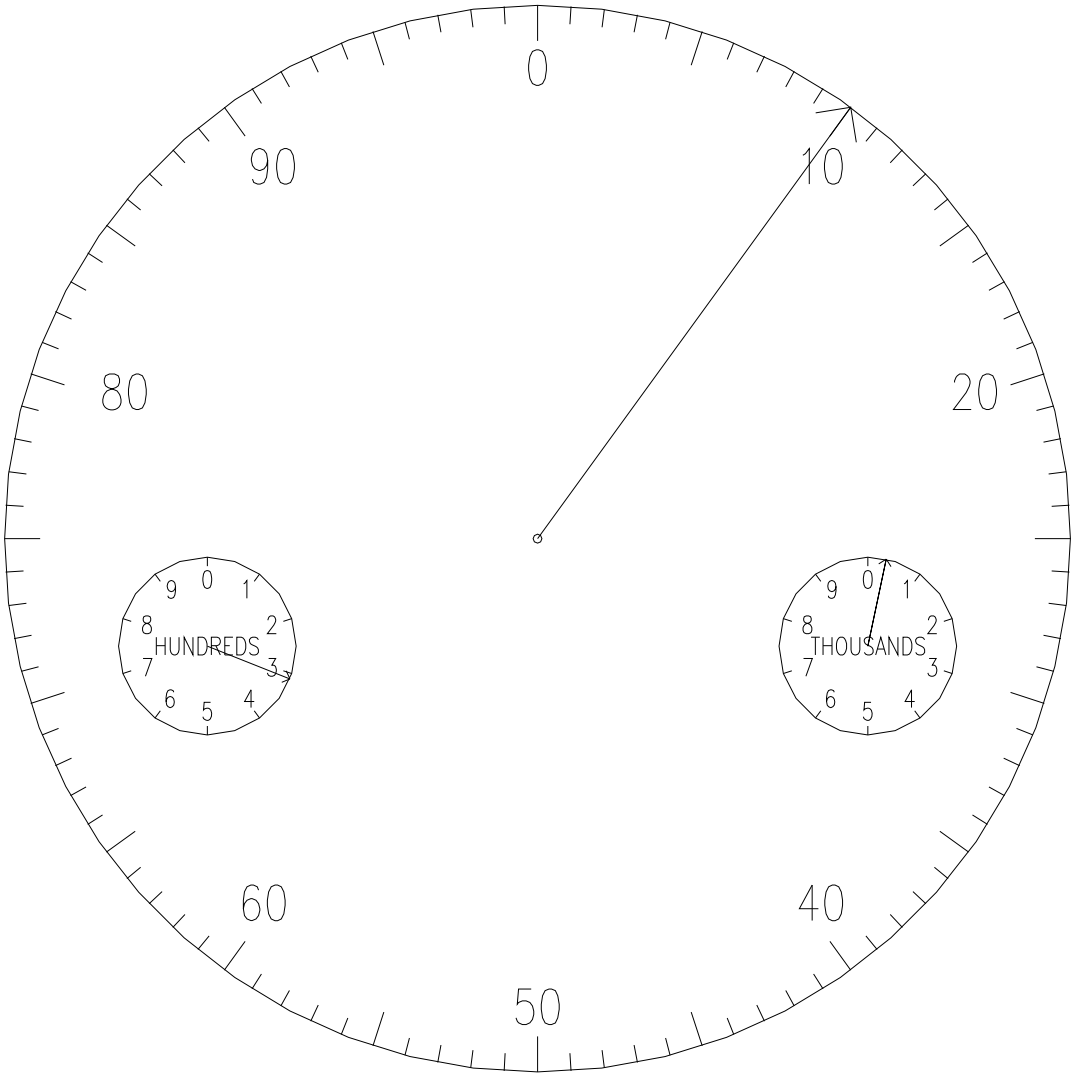
In taking a reading a place is first found where the air ahs a straight course and will not be deflected unequally to either side, and where the area of the airway can be measured.

Hold the anemometer at arm's length in such a way that the blades will turn in a plane at right angles to the air current, using reset lever on anemometer, so all dial hands will be on zero, the brake lever near handle is released and anemometer exposed to the air current for one full minute, moving about so as to obtain an average reading for the enter sectional area of the airway after which the brake is applied. The reading of the anemometer times the area of the airway in square feet gives the quantity of air passing in cubic feet per minute.

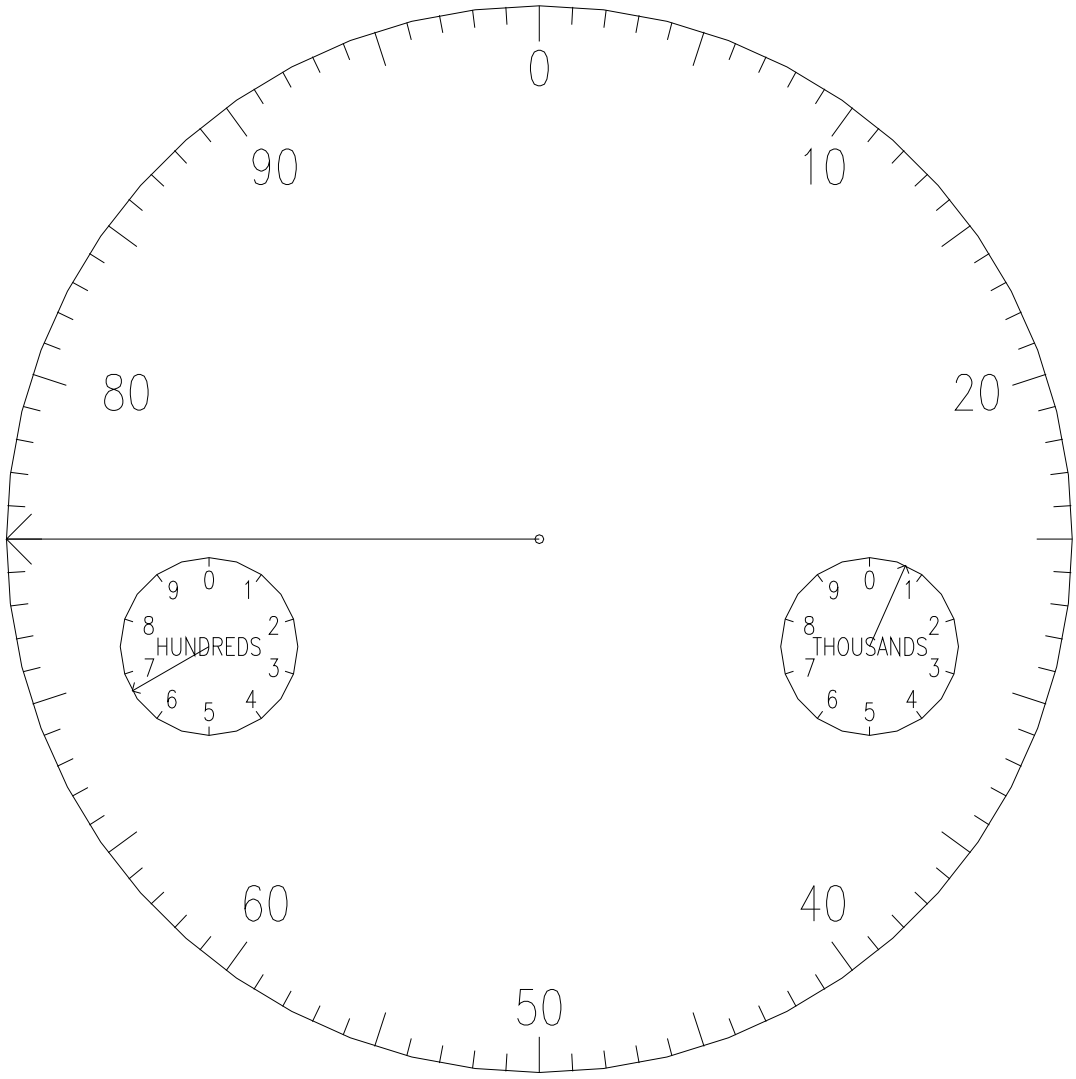
Example Problem: How would you determine the quantity of air passing where the section of the airway is ten feet wide, five feet high, and the air velocity of the anemometer reads 300?

Answer: Calculate the sectional area of the airway, thus: 10 x 5 = 50 sq. ft. the quantity of air passing is 300 x 50 = 15,000 cu. ft. per minute.

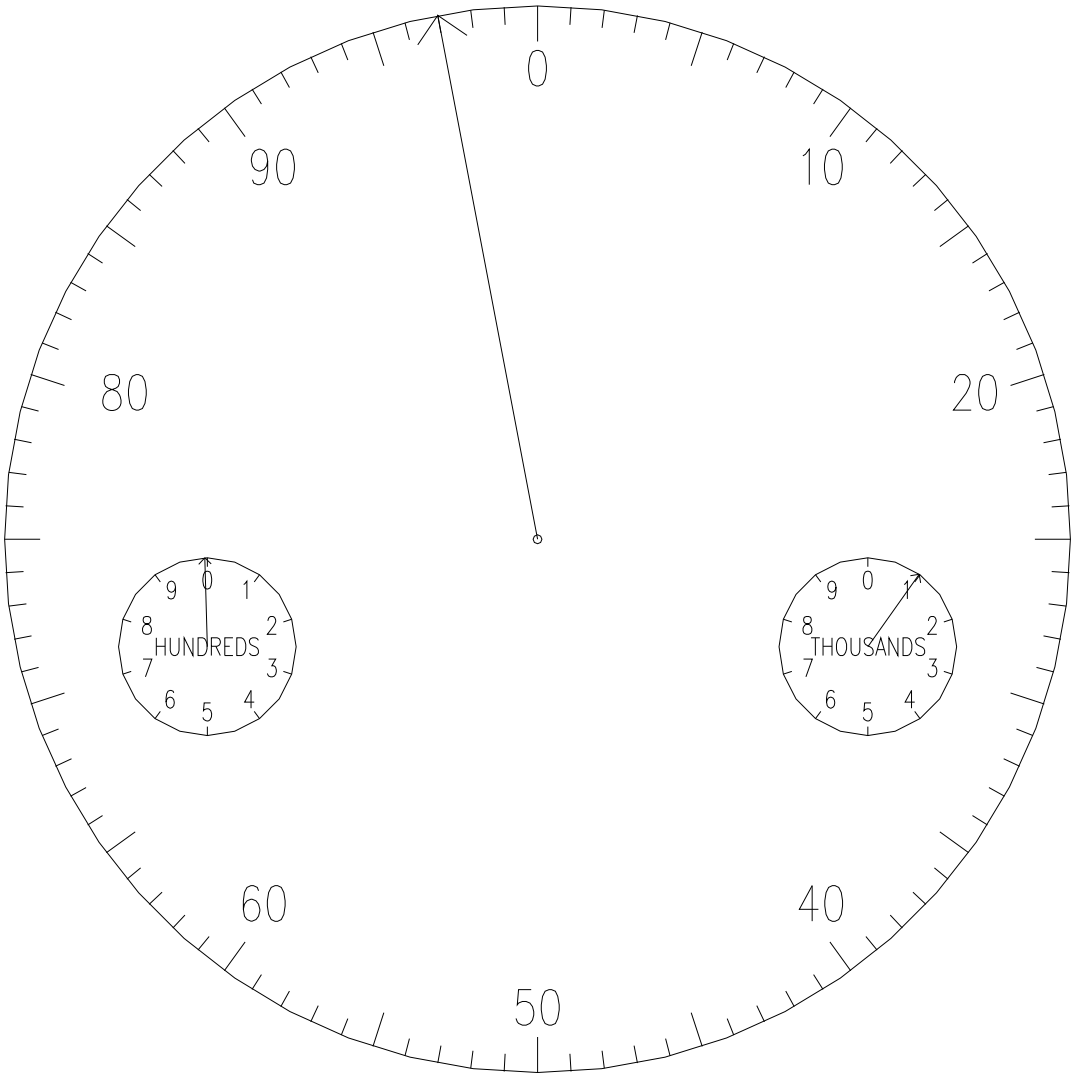
Air reading - 310 (Velocity)



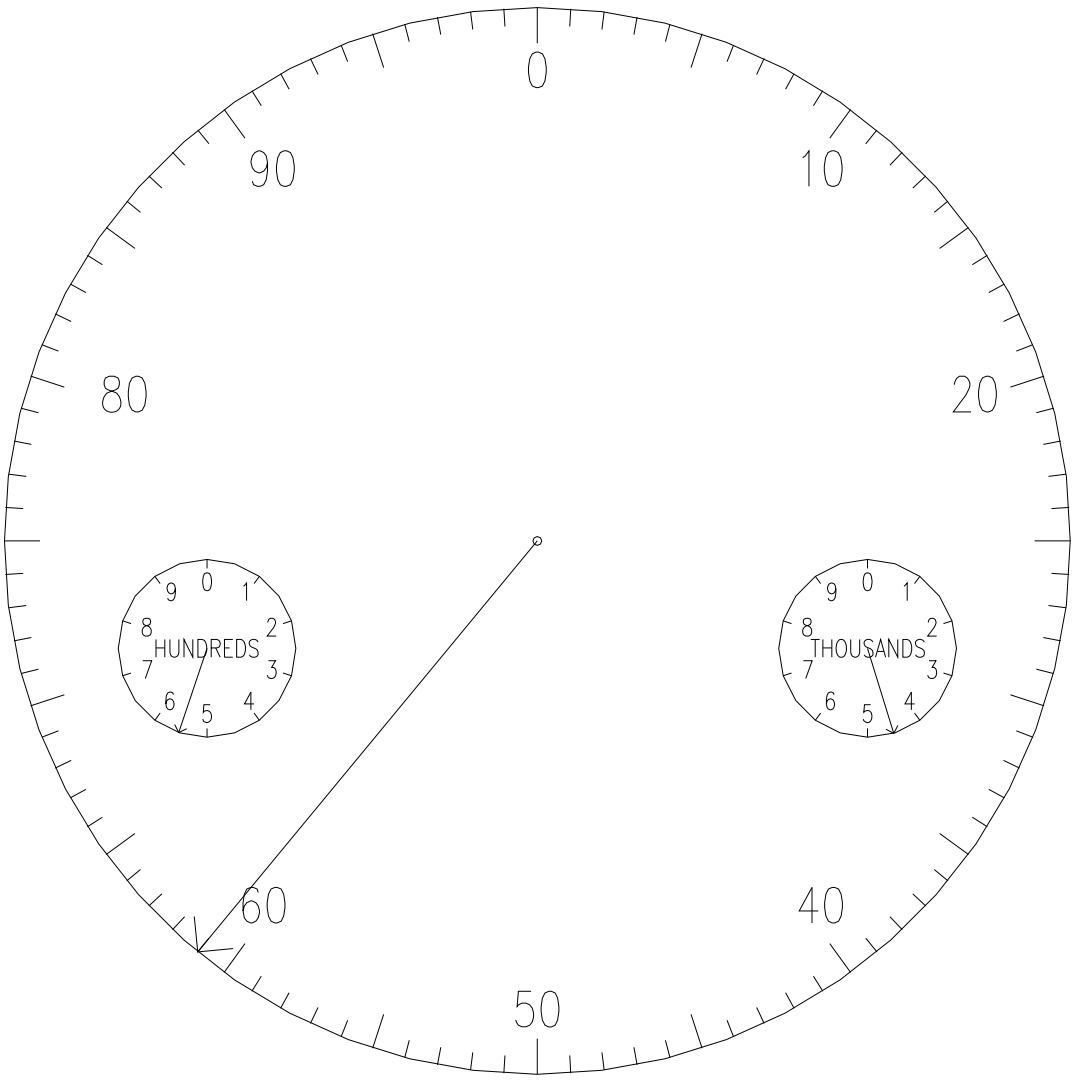
675 (Velocity)



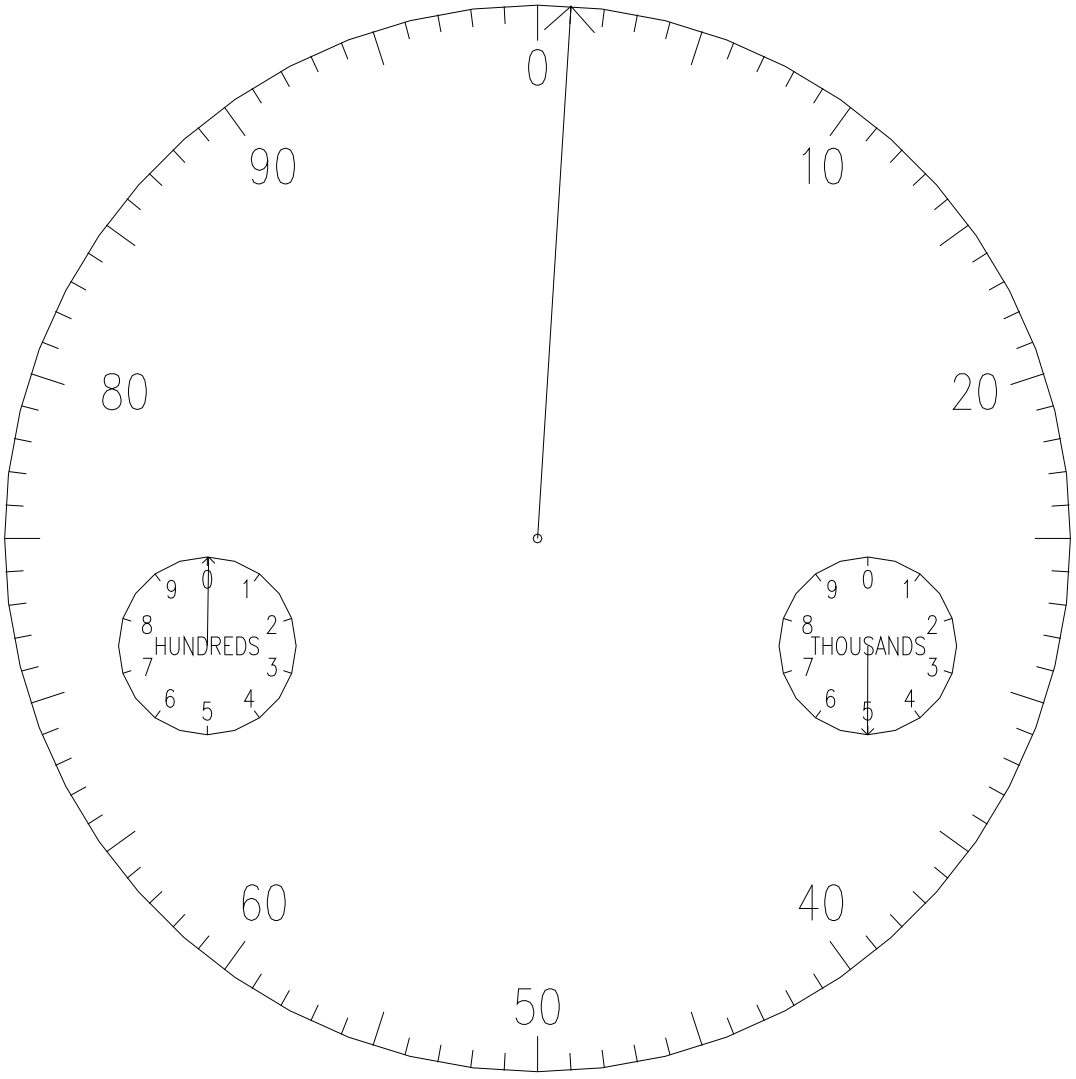
997- (Velocity)



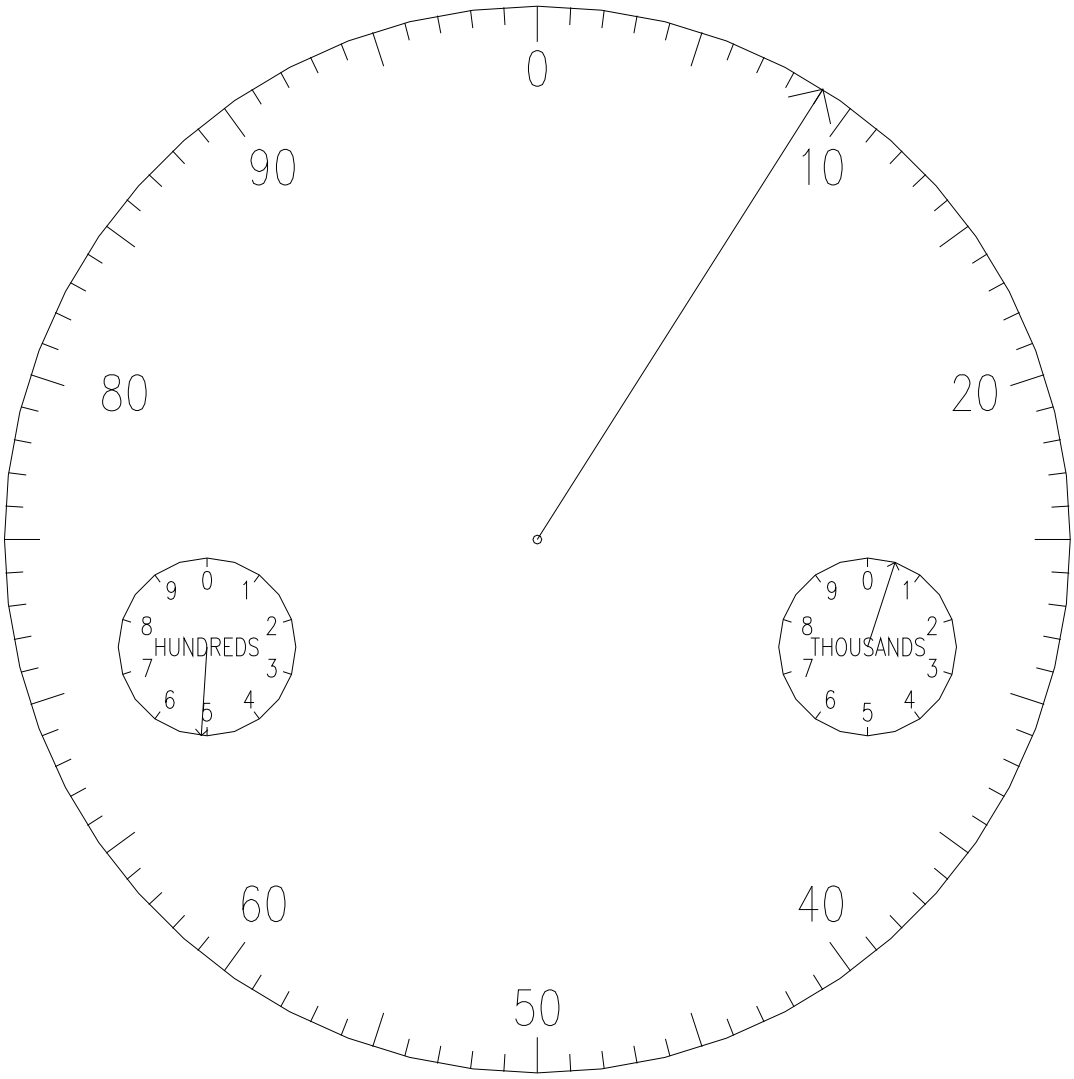
4,561 (Velocity)



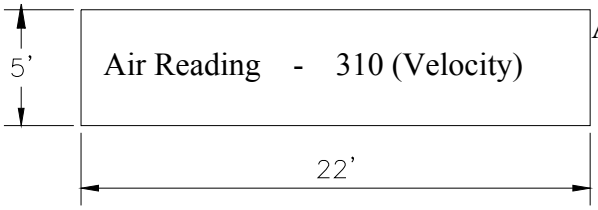
5,001 (Velocity)



509 (Velocity)

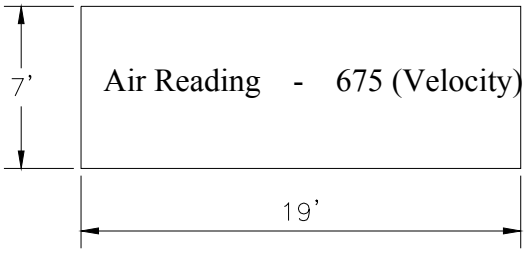

0
10
20
40
50
60
80
90
HUNDREDS
0 1 2 3 4 5 6 7 8 9
THOUSANDS
0 1 2 3 4 5 6 7 8 9

Find The Square Feet



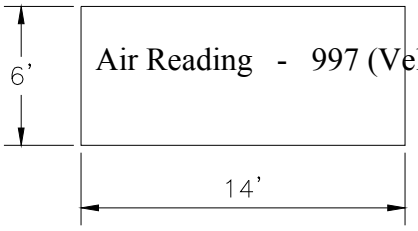
Area = 5 x 22 = 110 Sq. Ft.

Answer: 34,100 Cu. Ft. Per Minute



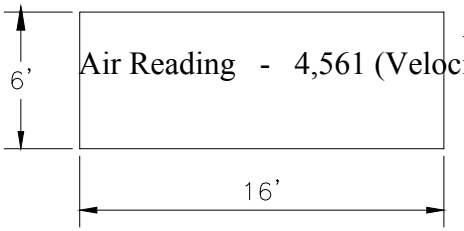
Area = 7 x 19 = 133 Sq. Ft.

Answer: 89,775 Cu. Ft. Per Minute



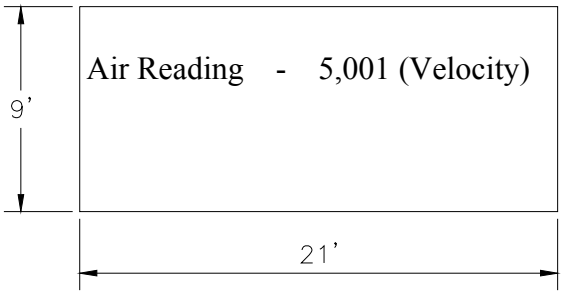
Area = 6 x 14 = 84 Sq. Ft.

Answer: 83,748 Cu. Ft. Per Minute



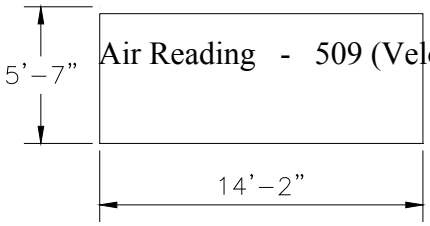
Area = 6 x 16 = 96 Sq. Ft.

Answer: 437,856 Cu. Ft. Per Minute



Area = 9 x 21 = 189 Sq. Ft.

Answer: 945,189 Cu. Ft. Per Minute



Area = 5.583 x 14.167 = 79.09 Sq. Ft.

Answer: 40,259 Cu Ft. Per Minute

BAROMETER

1. What common varying conditions of mine air are determined by measuring devices?
2. What is a barometer?
3. What are the two common types of barometers?
4. What is the principle by which a mercurial barometer operates?
5. How does the aneroid barometer operate?
6. What is atmospheric pressure?
7. What is the normal pressure of air on the earths surface at sea level?
8. What is the barometer reading for normal air pressure at sea level?
9. How may pounds of atmospheric pressure per square inch are denoted by one inch of mercury column?
10. How does elevation affect the reading of barometer?
11. What factors change the reading of a barometer?
12. What value is a barometer relative to mine ventilation?
13. How may a sudden marked reduction in atmospheric pressure affect the atmosphere of a mine?
14. What is the average change in the reading of a barometer for each one hundred feet in elevation?

WATER GAUGE

15. What is a water gauge?
16. Of what does a water gauge consist?
17. How is a water gauge used to determine differences in air pressure?
18. How is ventilating pressure determined by the water gauge?
19. How is a water gauge graduated?
20. What pressure is denoted by each inch difference in the level of the water columns?
21. How is the value of 5.2 pounds per square foot per inch of water gauge found?
22. At what point can the total mine resistance be determined?

THERMOMETER

23. What is a thermometer?
24. How does a thermometer operate?
25. What liquids are usually used in the column of thermometer?
26. For what purposes are thermometers usually used in mines?
27. What is a psychrometer?
28. How is relative humidity determined by the psychrometer?
29. What scales are used to measure temperatures?
30. What is the freezing point on a Fahrenheit scale?
31. What is the freezing point on a Centigrade scale?
32. What is the boiling point on a Fahrenheit scale?
33. What is the boiling point of the Centigrade scale?
34. How is a Fahrenheit reading converted to Centigrade?
35. How is Centigrade reading converted to Fahrenheit?

ANEMOMETER

36. What is an anemometer?

37. How are air velocities determined by an anemometer?

38. How is an anemometer graduated?

39. What period of time is usually taken for measuring air velocities?

40. How is an anemometer used to obtain velocities in mines?

ANSWER SHEET FOR BAROMETER

1. Pressure, temperature, velocity and humidity.
2. An instrument for determining atmospheric pressure or elevation.
3. The mercurial barometer and the aneroid barometer.
4. Atmospheric pressure is determined by the height to which a mercury column is raised in a vacuum.
5. The movement of one side of the instrument, which rises or falls as the outside pressure changes is shown on the dial which is graduated in inches of mercurial column and in feet indicating elevation.
6. The pressure exerted by the column of air above a given point.
7. About 14.7 pounds per square inch.
8. Thirty (30) inches
9. 0.491 pound.
10. The reading varies with the weight of the atmosphere. As we ascend, the reading becomes less; as we descend it becomes greater.
11. Changes in atmospheric pressure due to temperature, humidity, and elevation.
12. A falling barometer warns against decreased air pressure.
13. By permitting gases in large abandoned areas to expand into active workings. (In well ventilated mines the effect of expansion from abandoned areas is negligible).
14. Approximately one tenth (1/10) inch.

ANSWER SHEET FOR WATER GAUGE

15. An instrument to determine differences in air pressure.
16. The water gauge consists of a glass U tube partially filled with water and open at both ends.
17. By connecting the ends of the tube to the points between which the difference is to be measured.
18. By the difference in elevation of the two water columns.
19. In inches and tenths thereof.
20. 5.2 pounds per square foot.
21. One (1) square foot of water one (1) foot deep weighs 62.5 pounds; therefore, one (1) square foot of water one (1) inch deep weighs 62.5 4 12 = 5.2 pounds.
22. At the fan

ANSWER SHEET FOR THERMOMETER

23. An instrument for determining temperature.
24. By the expansion and contraction of a liquid column under varying temperatures.
25. Mercury or alcohol.
26. To measure temperatures of sealed areas and to determine the relative humidity of mine air.
27. A combination of wet and dry bulb thermometers.
28. By the difference indicated between the dry and the wet bulb temperatures.
29. Fahrenheit and Centigrade.
30. Thirty-two (32^o) degrees.
31. Zero.
32. Two hundred and twelve (212^o) degrees.
33. One hundred (100^o) degrees.
34. Centigrade = $\frac{5\ (F^o\ -\ 32^o)}{9}$
35. Fahrenheit = $\frac{9\ C^o\ +\ 32^o}{5}$

ANSWER SHEET FOR ANEMOMETER

36. An instrument resembling a small disk fan used to measure lineal feet of air travel.
37. By the lineal feet of air travel as recorded on the dials by the revolutions of the fan shaft.
38. To record the lineal feet of air travel.
39. Usually for one minute.
40. It is held in an air current for a given period of time to determine lineal feet of air passing each minute.

M-S-A METHANOMETER
MODEL M-402

GENERAL DESCRIPTION

The M-S-A Methanometer M-402 is a completely self contained portable methane indicator no larger than an ordinary transistor pocket radio. It is housed in an impact resistant molded plastic case and weighs less than 18 ounces. This instrument permits rapid and accurate measurements of methane gas concentrations.

The Methanometer M-403 has been assigned approval No. 8C-18 by the U.S. Bureau of Mines for having met the requirements of Schedule 8C.

Two unique features have been incorporated into the design of the M-S-A Methanometer. Both have been patented and M-S-A is the exclusive licensee in the U.S.A for their manufacture and/or use.

The first of these is the use of the palletized filament (pelement) in the Wheatstone bridge circuit. A pelement is an electrically heated device whose design utilizes a very small ceramic bead supported on a coiled filament. It operates at a temperature that is approximately half that of a conventional platinum wire filament. It uses very little power has practically no zero drift and has an exceptionally long life. Whereas the high conventional platinum wire filament causes and accelerated rate of vaporization of the filament surface which tends to increase the drift of bridge zero indication.

The second truly unique development is that the meter will indicate upscale for any concentration of methane gas. At concentrations up to 5% the meter will indicate the exact concentration; at any concentration above 5% the meter pointer will show the presence of methane by moving further upscale into the red warning range of the scale. (In conventional methane detectors the meter pointer begins to return down-scale toward zero when high concentrations are present, thus permitting the possibility of ambiguous indications is made possible by the use of a patented electrical circuit which utilizes four pelements in the **circuit** design. The specific functions of these pelements are described in the section titled **"PRINCIPLE OF OPERATION"**

This instrument is designed for one hand operation. Solid state components and printed circuit boards are used to achieve a rugged compact construction. All circuits are activated by means of push bottom switches.

The Methanometer is powered by a rechargeable nickel cadmium battery of sufficient capacity to permit more than 250 tests. A simple check can be made at any time to determine the state of battery charge. The battery charging receptacle is located behind a sliding cover which is locked in the closed position except when the battery is being charged. Two battery chargers are available for use with the Methanometer. One is a single unit battery charger (Mono-Battery Charger). The other is a ten unit battery charger.

Sampling is accomplished by means of an internal, motor driven, diaphragm pump unit which is activated by the push button switch on the lower left side of the instrument. The required sampling time is 3 seconds and the rate of sample flow will be a minimum of 0.3 liter/min.. The sample inlet fitting houses a replaceable cylindrical filter whose large surface area protects the flow system from dust and other air borne particulates. The sample is drawn through the combustion chamber block.

Which contains the four pelements and then is exhausted through the recessed fitting on the bottom of the plastic case.

The indicating meter has a dual range scale. The more sensitive scale range indicates concentrations of 0 to 2% methane in air. The indicating accuracy of this range is within + 0.1%. The other scale range indicates concentration of 1.6% to 5% methane with a tolerance within + 5% of the indication. When either range push button switch is activated a lamp illuminates the scale thus permitting reading in dark areas. This illuminating lamp is not a part of the measuring circuit. The plastic window of the meter contains a vaporized metallic deposit on its underside to prevent electrostatic charging, which, if it were permitted to accumulate, could affect the accuracy of indication.

The instrument may be held at any angle or position when samples are taken, however, when indications are being read or instrument checks are being made, the Methanometer should be held at an angle of approximately 45 degrees to ensure the most accurate indication by the mere pointer. This ^{o} angle is known and the "operating position".

Each Methanometer can be identified by its serial number which is found on a plate adjacent to the charging slide cover on the bottom of the case. Any inquiries directed to Mine Safety Appliances Company should include a reference to the serial number on the instrument.

It is recommended that the ever ready carrying case be purchased as an accessory to protect the instrument against the effects of bumps and hard knocks. It contains the necessary cut-outs to permit the instrument to remain in the case when sampling and measuring or performing the instrument checks.

Other accessories are also available for use with the Methanometer. The part number and a brief description of each will be found in the section titled **"REPLACEMENT PARTS AND ACCESSORIES".**

PRINCIPLE OFOPERATION

The Methanometer's ability to detect the presence of methane is achieved by two different measuring principles, which operate independently of one another. At concentration within the scale range of the instrument, methane is measure by a catalytic combustion system. In this system two pelements, one a detector which has been catalytically activated and the other a compensator, are connected in a in a symmetrical Wheatstone bridge circuit. If methane is present in the sample, it is burned by the detector pelement. This increases the temperature of the detector pelement, thereby, increasing its resistance which results is an unbalancing of the Wheatstone bridge. The meter, which is connected across the bridge, gives an indication that is equivalent to the concentration of methane in the sample.

At higher concentrations of methane, an additional pair of pelements give a thrermal conductivity signal. One of these, the thermal conductivity pelement, is located in the sample stream. The other, the compensator pelement. Is sealed in an air-filled chamber. If there is a high thermal conductivity properties of methane. Thus, the voltage across the thermal conductivity pelement will decrease and cause an electronic switch to operate. The meter, connected to the output conductivity principle of operation, high concentrations of methane up to and including 100% will result in an indication in the red warning range.

All four pelements mounted in a common combustion chamber block. The low temperature at which they operate assures a long service life. Bridge zero and span adjustments are necessary only after long periods of operation.

INSTRUMENT CHECKS BEFORE TESTING

The instrument should be checked according to the following instructions before beginning each series of tests.

CAUTION: Do not remove the back cover or open the charging slider underground or in areas where a hazardous concentration of combustible substances may be present in the atmosphere.

MECHANICAL ZERO CHECK

Hold the instrument in the operating position (approximately 45^{o} angle) without pressing any switch button and observe the position of the meter pointer. It must not differ by more than + 0.05% from the zero mark on the scale. If it deviates by more than this value, the mechanical zero must be adjusted as follows: using the special screwdriver provided, remove the three triangular head screws that mount the back cover. Gently pry up and remove the cover.

While holding the instrument in the operating position, and without pressing any switch button, turn the adjusting screw, located at the lower rear center of the meter, with a suitable screwdriver until the pointer is positioned on the zero mark of the scale.

BATTERY VOLTAGE CHECK

Press the pump switch button and take a fresh air sample for 3 seconds; then release the button. Hold the instrument in the operating position. Simultaneously press the 0-2 switch button and the recessed push button switch marked "CHECK" on the upper left side of the case (it will be necessary to use a small diameter blunt object to do this). If the meter pointer indicates in the red areas of the scale, the battery is fully charged. If the pointer indicates 1.7 (red triangle) or below, measurements of gas concentrations and the electrical zero check **must not** be carried out as erroneous indications may result. The 1.7 indication corresponds to the permissible end discharge voltage of the battery. The battery must be recharged before proceeding. An indication between the above two points will permit an approximation of the battery charge condition. Check the battery voltage with increasing frequency when it is known that the battery is near the discharged condition.

ELECTRICAL ZERO CHECK

Hole the instrument in the operating position. Press the pump switch button and take a fresh air sample for 3 seconds; then release the button. Wait for 5 seconds then press the 0-2 switch button. The meter pointer will first deflect to the left and then move back toward zero. When it comes to rest observe the position of the pointer. It must not deviate by more than + 0.05% from the zero mark on the scale. If the deviation is greater than this value, the electrical zero must be adjusted as follow: Take a fresh air sample for 3 seconds; wait for 5 seconds; press the 0-2 switch button and wait until the meter pointer comes to rest. While continuing to hold the 0-2 switch button, bring the instrument into the operating position and adjust the potentiometer, identified as "O", with a suitable screwdriver until

the pointer is positioned on the zero mark of the scale. Repeat the electrical zero check and readjust the potentiometer if necessary.

CAUTION: take care not to mistakenly turn either of the span potentiometers, which are located to the right of the zero potentiometer .

Replace the back cover and gently press to seat it onto the instrument case. Replace and tighten the three screws.

OPERATING INSTRUCTIONS

1. Hold the Methanometer in the right hand in a manner that will permit the thumb to rest on the switch button of the desired measuring range, and the ring (third) finger on the switch button of the sampling pump.
2. Place the inlet at the sampling point. Take care that no water or other liquid is drawn into the instrument as damage will occur.
3. Press the pump switch button and hold for at least 3 seconds; then release the button.
4. Wait for 5 seconds during which time the instrument should be brought into the operating position (approximately 45^{o} angle). Press the switch button for the desired measuring range. The meter pointer will first deflect to the left and then move upscale above zero to a point of maximum value where it will pause momentarily before returning downscale to zero.
5. The maximum upscale reading corresponds to the methane concentration at the sampling point. If the methane concentration is above 5% the meter pointer will remain in the red portion of the scale for a period of time dependent upon the concentration. (**NOTE:** If a high concentration is indicated, flush the flow system with a adequate quantity of fresh air to remove any residual traces of methane before further tests are made for the electrical zero is checked).
6. If a sampling tube or probe is to be used with the methanometer connect simply by pressing the tube over the inlet fitting. Direct the inlet end to the point from which the sample is to be taken (make sure that no liquid is drawn into the tube or probe). Sample and measure in the manner previously described except allow an additional 4 seconds of sampling time for each three feet of sampling tube or probe. (Example: If the six feet long sampling tube is used, sample for a minimum of 11 seconds).

MAINTENANCE

The Methanometer should have a long consistently accurate service life if the following few maintenance instructions are observed. Remember as is the case with any precision instrument it should be handled carefully and kept clean and dry at all times.

CAUTION: Do not remove the back cover or open the charging slider underground or in areas where a hazardous concentration of combustible substances may be present in the atmosphere.

CLEANING THE INSTRUMENT

The instrument may be cleaned externally by brushing or by wiping with a dry rag. Clean the inside by using a soft bristle brush. **Never** use compressed air for cleaning since it is possible that sensitive components may be damaged or coated with an oil film.

FILTER REPLACEMENT

The frequency of filter replacement will be dependent upon how often samples are taken and the level of air borne particulates. It is recommended that the filter be replaced each week (more often if conditions warrant it) as follows:

1. Unscrew the sample inlet fitting, using a suitable wrench, while holding the instrument upside down to prevent loose dust from falling into the flow system. Make sure that the sealing gasket does not get lost.
2. Remove the soiled filter from the fitting and discard it. Insert a clean filter pushing is gently into the fitting until it strikes a stop.
3. Screw the inlet fitting containing the filter into its bushing. Turn it down tight enough to prevent leakage but do not over tighten.

RECHARGING THE BATTERY

When the battery voltage check indicates a reading below 1.7 (red triangle) the battery is completely discharged and must be recharged as follows before the instrument can be used again:

1. Using the special screwdriver provided, turn the triangular head screw marked "CHARGE" to the right and hold in that position. Slide the cover outward thereby exposing the charging receptacle.
2. Connect the methanometer to the monocharger by means of the charging cable.
3. Plug the monocharger power cord into a 115V 50-60 cycle outlet. The green lamp will light to indicate that the charger is operating.
4. Charge the battery for a period of time in accordance with the following schedule.

SCHEDULE I

BATTERY VOLTAGE CHECK INDICATION	DISCHARGE CONDITION OF BATTERY	REQUIRED CHARGING TIME
1.7% (RED TRIANGLE	Completely discharged	14 hours
1.8%	Three-fourths discharged	11 hours
1.9%	Half discharged	7 hours

Note: Occasional overcharging of the battery will not be harmful, however overcharging will result in a reduced battery cycle life.

NATIONAL MINE SERVICE METHANOMETER G-70
U.S. BUREAU OF MINES #86-19

INSTRUCTIONS FOR THE USE OF PORTABLE MEASURING INSTRUMENT G-70

Although the G-70 is designed for underground use it is a scientific instrument and should be handled with care, remaining fastened in the leather case.

MEASURING PROCEDURE

The measuring procedure is started by depressing the upper or lower measuring range button marked 2 or 5. This procedure is automatically controlled and the button must remain depressed during the entire measuring operation.

The button (2) covers the measuring range 0-2% methane (upper graduation on scale), whereas the lower button (5) relates to measurements within the range of 1.8-5% methane (lower graduation on scale). When the 2 or 5 button is depressed, the suction pump starts operation, pumping time being automatically controlled. The measuring procedure will automatically follow suit. The button must remain depressed until the pointer has reached its maximum deflection on the reading dial. The indicator must not be adjusted while the pump is in operation, only when the pump has stopped.

MEASURING SCALE

The measuring scale (arranged at the upper left of the instrument) is sub divided into upper graduations for the measuring range form 0-2% methane, and lower graduations for the measuring range from 1.8-5% methane. If the upper measuring range button (2) is depressed, the reading must be taken from the upper scale, if the lower measuring range button (5) is depressed, the reading is taken from the lower scale. Both scales are referred to a common mechanical and electrical zero point.

THE METHANE INDICATOR POINTER

In any atmosphere the needle will always, before giving a reading, deflect first to the left of the scale. This indicates that the instrument is in order.

METHANE FREE ATMOSPHERE

Operation of methane indicator needle if the test volume sampled is free of methane. On completion of the timed pump operation, the pointer will first deflect to the left, as the measuring procedure commences, but will then return to the right until it has reached the zero point.

0.6% METHANE SAMPLE

Operation of methane indicator needle if the test volume sampled contains 0.6% methane.

Needle will first move to the left as shown in Fig. 1, it will then deflect to the right until it has reached the mark on the dial corresponding to 0.6%, as contained in the test volume sampled, thereby ensuring

the necessary measuring accuracy of + 0.1% methane. This procedure applies to methane contents of up to 2% (upper scale of the dial) and/or 5% (lower scale of the dial).

Operation of methane indicator needle in the case of Methane contents exceeding 2% and 5%

The portable measuring instrument G-70 makes it possible to also detect in a quite simple manner methane contents exceeding the ranges of up to 2% methane and 5%.

Shows measurement of sample exceeding 5% but Less than 15% methane

The needle deflects quickly from the zero point to the right, passing off the scale until it comes to standstill at the stop pin on the dial; it will rest here for 2-12 seconds depending on the methane content of the sample which in this case ranges between the maximum dial value and 15% contains approximately 14% methane, whereas a methane content of 12% would cause the needle to remain at this stop pin for approximately 3 seconds, returning to the left and stopping to the left of the zero point.

Exceeding 15% but less than 60% methane

The pointer deflects spontaneously to the right but returns immediately to the left of the zero point where it will remain until the respective measuring range button has been released.

Sample between 60%-100% methane

On expiration of the pump operation time, the pointer deflects very quickly fro the zero point to the left of zero where it remains until the respective measuring range button has been released.

VOLTAGE CONTROL

The portable methanometer G-70 is powered by 1 DEAC DKZ 4/500 cell, the capacity of which is adequate for approximately 300 measurements of 10-12 seconds duration. The voltage indicator of this battery situated in the upper tight of the instrument show the battery voltage during each operation. The following defection characteristics of the voltage indicator

ZERO POINT ADJUSTMENT

The methane indicator needle can only be checked at the surface. By depressing button (2) a complete measuring procedure will be carried out; on completion of this measuring procedure, the needle must exactly coincide with the dial zero point. If the needle does not coincide with the zero point, corrective adjustment of the zero position must be effected. This is doen by removing the wax filling and adjusting the zero point potentionmeter on the right side face of the instrument by means of a special screwdriver. Care must be taken, however, that the button (2) remains depressed after completion of the sampling procedure, while this adjustment is being performed. After this correction another complete measuring procedure must be carried out, thereby rechecking the pointer as to its coincidence with the zero point. Thereafter assuming everything is correct replacing the wax filling.

CHARGING THE INSTRUMENT

Firstly, remove the wax filling covering the special screw at the left side face of the instrument. This screw has to be removed by means of a key, which must be always kept at the place wither the battery is charged or in the lamp room. The female socket for the connection of the battery charger plug is thereby accessible and the methanometer can be put on charge. When the battery is fully discharged I the voltage control pointer remains on the red area of the two color disk) the charging time is ten hours. After completion of the charging procedure, the voltage will checked by depressing button (2) and, at the same time, observing the voltage control pointer on the red-white color disc. The voltage control pointer must remain on the white area.

GENERAL

The portable methanometer G-70 is normally supplied for operation with two measuring ranges. If the instrument is to operate only within one measuring scale the other measuring scale is excluded by locking out button (5).

ACCESSORIES

The G-70 methanometer may be fitted with telescopic sampling probes of different length, i.e. 0.80 m, 1.26 m, 2.00 m. Convenient cases to carry the instrument by hand or to fasten it to the belt, or fitted with shoulder straps can be supplied. The G-70 is also available under the designation G-70 F in which case it serves as stationary remote metering head for use with automated monitoring systems.

M-S-A METHANE SPOTTER

IMPORTANT WARNING

Like any piece of complex equipment, the Methane Spotter will provide the protection it is designed to give only if it is used and serviced in accordance with the manufacturer's instructions. This manual must be carefully read by all individuals who have or will have the responsibility for operating or servicing you Methane Spotter. The warranties made by Mine Safety Appliances Company with respect to the instrument are voided if the instrument is not used and serviced in accordance with the instructions in this manual. Please protect yourself and your employees by following them.

CONDENSED OPERATING INSTRUCTIONS

CAUTION

The Methane Spotter and its accessory parts must be operated only by experienced technicians who have read this instruction booklet carefully, and are specifically trained in methane detection techniques and safety procedures.

To Test Battery

1. Depress both test and check push button switches and hold down for 15 seconds. If meter pointer indicates in battery segment of meter battery charge is adequate and

methane test may be made. If meter pointer indicates below battery segment, battery must be charged.

To Test For Presence of Methane

1. Take the instrument into the atmosphere to be measured.
2. Depress TEST switch and hold for 15 seconds or until a steady meter reading is obtained.
3. read methane concentration on meter scale.

DETAILED OPERATING INSTRUCTIONS

LIMITATIONS

CAUTION

Silanes, Silicones, Silicates and other compounds containing Silicon (which are sometimes used as hydraulic fluids or lubricants) or tetraethyl lead in the tested atmosphere may seriously impair the response of the instrument. Some of these materials rapidly "poison" the detector filament so it will not function properly. When the presence of such materials is even suspected to be in the atmosphere being tested, the instrument must be checked at least after every 5 tests, using the Calibration Kit, part number 457365. If the instrument reads low on the test gas in the calibration kit, check battery condition and zero adjustment and repeat the calibration procedure. If the test gas still indicates low the instrument should be returned to the factory.

Battery Test (Figure 1)

The M-S-A methane spotter operates from power supplied by a rechargeable nickel cadmium battery assembly, consisting of two nickel cadmium cells.

CAUTION

The battery must be tested before each series of tests for the presence of methane. If at any time a battery CHECK indicates near the left side of the battery segment of the test meter, the battery should be tested frequently during any test for methane. Never make a methane test if battery test indicates below battery segment of meter, as you will not obtain an accurate measurement of the methane concentration present.

To Test Battery

1. Remove the instrument from the leather carrying case if used. At the same time, depress both the TEST and CHECK pushbuttons (Figure 1) and hold pushbuttons, depressed for at least 15 seconds. **Note:** That the meter pointer will swing upscale, then gradually return down scale and stop. If the meter pointer stops within the BATTERY segment of the meter scale, the battery is adequately charged for accurate testing.
2. If battery CHECK indicates below BATTERY segment of meter, battery needs recharging.

OPERATING INSTRSUCTIONS

1. Remove the instrument from the accessory carrying case if used. Place the left hand through the hand loop and hold the methane spotter so that the left thumb rests on the TEST button (Figure 2).

2. Depress the TEST button and hold it depressed for 15 seconds or until a steady meter reading is obtained.
3. Note the meter indication. The numerals on the meter scale indicate percent of methane (CH^4). Probe several places in the test area and note meter indications at all places tested. The concentration of 1% or less. The orange portion of the scale indicates methane concentrations of 1% to 2%. The red portion of the scale indicates methane concentrations of 3% to 5%.

WARNING

IN METHANE CONCENTRATION ABOVE 5% THIS INSTRUMENT MAY GIVE ERRONDEOUS DOWNSCALE INDICATIONS. WHERE CONCENTRATIONS HIGHER THAN 5% ARE SUSPECTED, INSTRUMENTS CAPABLE OF ACCURATE INDICATIONS ABOVE 5% SHOULD BE USED.

MAINTENANCE INSTRUCTIONS

User maintenance of the methane spotter consists of cleaning, battery charging, battery replacement, electrical zero test and adjustment, and checking for correct instrument calibration.

Tools and Accessories Required

1 screwdriver with 1/8" blade for removing slotted screws which hold back cover in place.
1 screwdriver with "blade for adjusting zero potentiometer.
1 soft dry cloth or soft brush for cleaning.
1 battery charger.
1 calibration kit.
1 volt-ohm-millimeter for checking operation of battery charger.

Cleaning

The outside of the instrument may never be cleaned with a soft brush or soft dry cloth. NEVER USE COMPRESSED AIR, SINCE DAMAGE TO THE INSTRUMENT OR A COATING OF OIL MAY RESULT. Keeping the instrument in its necessary leather case will help to keep the instrument clean.

At the time the instrument is cleaned, check to be sure the back cover screws are tight.

Battery Charging

CAUTION

To prevent ignition of gases, recharge batteries in a non-hazardous atmosphere.

Power for the methane spotter is supplied by a special nickel cadmium rechargeable battery assembly. Whenever the battery test gives a meter indication to the left of the BATTERY segment, the battery should be recharged.

To recharge the battery, either the monocharger or the ten-unit battery charger may be used.

NOTE

Frequent charging of the battery when it does not need recharging can result in the battery providing fewer than the normal number of test per charge. While this does not harm the battery, better operation can be obtained by charging the battery only when recharging is required.

Use only the M-S-A monocharger on ten-unit charger for charging batteries. These chargers are equipped with transistor regulator circuits to provide the proper charging rate for the methane spotter.

Using the Monocharger (Figure 3)

1. Remove the methane spotter from its leather carrying case, if used.
2. Raise the spring-loaded battery charge jack of the methane spotter. Push the plug asfar as it will
3. Plug the AC receptacle of the monocharger into a source of 117 VAC + 10% 50-60 cycles.
4. Charge the battery pack for 16 hours.

NOTE

Frequent overcharging by leaving the charger connected for more than 16 hours can reduce the life of the battery pack. Proper use of the charger should enable the battery pack to be recharged for 300 to 500 times before replacement will be required.

Using the Ten-Unit Battery Charger

The ten-unit battery charger permits from one to ten methane spotters to be charged at the same time. The ten-unit charger is used in exactly the same way as the monocharger. The ten-unit charger has a pilot lamp which glows when the unit is plugged into the AC source. The unit is also equipped with a 1 ampere 3AG fuse in an indicating fuse holder. If the fuse holder top glows, the fuse has blown.

CAUTION

To prevent ignition of gases, never remove the back of the instrument or replace the battery pack except in a non-hazardous atmosphere.

The methane spotter battery pack should be replaced when the battery pack can no longer be recharged or holds its charge for only a few hours. To replace the battery pack, proceed as follows:

1. With a 1/8" blade screwdriver, remove the four screw which hold the back of the methane battery in place and remove the back.
2. Remove the two battery contact retaining screws. With your hand over the battery pack, invert the methane spotter so that the battery pack falls out in your hand.
3. Bend the separate tabs of the new battery pack at right angles so that the holes in the tabs line up with battery contact screw holes.
4. Place battery pack in battery retaining compartment of case, with separate connection tabs facing up.

5. Place a screw removed in step 2, through black wire battery contact, then through the left battery tab and into the left battery contact threaded insert. Route the black wire.
6. Place the other screw removed in Step 2, through the red wire battery contact, then through the right battery tab and into the right battery contact threaded insert. Route the red wire.
7. Replace the back cover, and back cover screws. Tighten firmly, but do not over-tighten.
8. Check the condition of the new battery pack by following the battery test instructions on page 5. If the battery condition indication is low, recharge the battery pack according to the battery charging instructions.

Checking the Battery Charger

If the battery will not charge, as indicated by performing the battery check after a 16 hour charge, the battery charger may be checked as follows:

1. Be sure the AC outlet is supplying current. Plug a lamp, test meter, or other 117 volt appliance into the outlet to be sure current is present.

Checking the Electrical Zero of the Methane Spotter

The zero indication on the meter scale should be checked routinely at least once a week and more often if the methane spotter is used frequently. The zero check must be made with the instrument in air free of combustible gases or vapors.

Depress the test button and hold for 15 seconds. At the end of this time, the meter should indicate within the broad black band beneath the meter "O". Anywhere within this band is acceptable.

If instrument does not read zero, proceed as follows:

1. Remove back of the methane spotter.
2. Depress and hold TEST button and while observing meter, adjust poterntiometer screw labeled "Z" until meter indicates zero.

CAUTION

Never adjust either the "C" or "S" potentiometer screws or faulty calibration of the instrument will result.

3. Replace back of instrument.

If frequent zeroing of the instrument is required and battery pack is good, return the unit to the factory.

Using the Calibration Kit

The calibration kit provides a positive means of determining the accuracy of the instrument. Follow exactly the instructions printed below and in the lid of the calibration kit. If the instrument does not calibrate accurately, return it to the factory.

NOTE

The calibration is to be checked in fresh air (Area free of combustible gas)

1. Check instrument zero by depressing TEST button for 15 seconds. If a zero adjustment is necessary, refer to the instruction book.

2. Slide the ADAPTER ASSEMBLY onto the sensing head.
3. Connect plastic cup, gum rubber tube and balloon together as shown.
4. Deflate balloon completely by rolling towards cup
5. When deflated, close off gum rubber tube with pinch clamp.
6. Remove cover from gas can, exposing needle. Insert needle into gum rubber tube between pinch clamp and plastic cup and press push button on can, filling balloon. Fill to approximately 6" diameter. Remove gas can needle and replace cover on gas can.
7. Pinch the gum rubber tube closed with your fingers, remove the pinch clamp from the end of the tubing and slide the tubing onto the tube fitting.
8. Release fingers and allow several seconds for the gas to diffuse. Press the TEST button on the instrument and hold for 15 seconds. The meter should indicate the calibration gas concentration.

PRINCIPLES OF OPERATION

A unique, patented principle is incorporated in the methane spotter.

This principle employs palletized filaments or pelements in the measuring circuit. A pelement is an electrically heated device which uses a very small ceramic head supported on a coiled filament. The pelement operates at a temperature approximately half that of a conventional platinum wire. It uses very little power and has virtually no zero drift. Two pelements are used, one as a methane detector and the other as a bridge circuit comparator. The detector pelement is heated sufficiently to cause methane concentrations up to 5% to burn which changes the resistance of the pelement and unbalances the bridge circuit. This action causes the meter to indicate the equivalent concentration of methane in the sample up to 5%.

WARNING

IN CONCENTRATIONS OF METHANE ABOVE 5%, THE METER POINTER MAY MOVE DOWN-SCALE, GIVING ERRONEOUS INDICATIONS, WHERE METHAN CONCENTRATIONS HIGHER THAN 5% ARE SUSPECTED, INSTRUMENTS CAPABLE OF ACCURATE INDICATIONS ABOVE 5% SHOULD BE USED.

A flame arrestor and filter assemblies are incorporated in the diffusion head of the methane spotter. A special integrated circuit is employed as a meter driven and also prevents damage to the meter from overloads.

BACHARACH CANARY

1.0 PURPOSE

The Hand Held Permissible Indicating Methane Detector is a device that senses the presence of methane gas in the atmosphere and indicates the percentage concentration by volume. The instrument is certified as complying with requirements of the United States Bureau of Mines Schedule 8C, and has been granted Approval No. 8C-21.

2.0 FUNCTION

Methane in air surrounding the Sensor Cell diffuses through the porous metal sensing Head (flame arrestor) to an electrically heated catalytic element which is connected as one arm of a balance Wheatstone bridge.

Methane is air is burned (oxidized) when it comes in contact with a heated catalytic surface raises the temperature of the catalytic element, thus increasing the electrical resistance. The resistance is proportional to the temperature of the element and the amount of gas burned.
The change in resistance causes the Wheatstone bridge to become unbalanced, the degree of unbalanced being proportional to the amount of methane gas present in the immediate atmosphere. The gas concentration is then read directly on a meter graduated to indicate 0-5% methane. A heated reference element, in contact with methane present, but catalytically inactive, is connected as an adjacent leg of the Wheatstone bridge. This second element (reference) serves to compensate for variations in environmental conditions such as ambient temperature and pressure.

3.0 DESCRIPTION

The instrument consists of three major sub-assemblies, when combined, form one compact unit that can be conveniently carried in the hand, or strapped to an equipment belt. The total weight of the instrument ready for use is 16 ounces.

3.1 Sensor Cell 23-0980

The Sensor contains the active and reference elements suitably housed for protection against mechanical damage and entry of dust.

This gas sensitive assembly plugs into a seven pin socket located on top of Detector Assembly 23-7131. Pins 1 and 3 comprise the active element leg and Pins 5 and 7 are the reference element leg. The Assembly is enclosed within a porous metal flame arrestor that permits diffusion of the atmosphere for catalytic sensing of methane by the active element.

3.2 Detector Assembly 23-7131

The Detector Assembly incorporates the electrical circuit that detects the change marked “CHARGE” is used. A captive retaining screw provides a positive lock to hold the two sections of the instrument together. The Power Pack can readily be disassembled from the Detector Assembly for charging by inserting the two pronged Wrench (23-0977) into the mating holes located in the captive screw head.

The Battery Pack will provide a duty cycle of up to a maximum of 75 sampling tests in an 8-hour period considering an average duration of 20 seconds for each test.

4.0 OPERATING CONTROLS

The instrument has two operating controls, two electrical adjusting controls, and a mechanical meter zero adjuster.

1. "METHANE SAMPLE" push button; located on front case and connects the battery to the Detector circuitry when depressed.
2. "BATTERY VOLTAGE" pushbutton; located in front of the Detector Assembly, functions to connect the meter into the circuit as a voltmeter. Both METHANE SMAPLE and BATTERY VOLTAGE buttons **must be depressed simultaneously** for meter to indicate state of charge of the batteries.
3. 'ZERO" set potentiometer; located in the Detector Assembly interface, contains a slotted adjustment screw for setting electrical zero.
4. "CALIBRATION" Span Adjustment potentiometer; also located in the Detector Assembly interface, is used to calibrate the meter at a known methane in air concentration.
5. MECHANICAL ZERO (for meter); located below meter face, is used to mechanically set the pointer to scale zero **without** electrical circuits energized (no pushbuttons depressed).

NOTE

The meter has a green index mark on the scale for minimum battery voltage (10 volts). DO NOT ATTEMPT TO USE INSTRUMENT OR MEASURE GAS CONCENTRATION WHEN VOLTAGE INDICATED IS BELOW THIS LEVEL.

4.1 Operational Check

The instrument is initially calibrated at the factory. Upon receipt, however, the instrument should be checked in fresh air (free of combustible gases) before tests in potentially gassy atmospheres are attempted.

a. Position instrument vertically, and observe whether meter pointer rests on scale zero. If not, reset to zero before continuing with the operational check. THIS IS A MECHANICAL ADJUSTMENT ONLY. NO PUSHBUTTONS SHOULD BE DEPTERSSED.

b. Press the METHANE SAMPLE pushbutton and keep it engaged. Simultaneously press the BATTERY VOLTAGE button and observe maximum meter indication for 10 seconds. A deflection above the green index mark (BATTERY OK) indicates sufficient voltage to proceed with methane test.

c. Release BATTERY VOLTAGE Button but continue to hold METHANE SMAPLE button engaged. Observe that meter pointer stabilizes at zero after 10-15 seconds. If meter does not return to zero; proceed with Section 4.3.

4.2 To Operate

Step 1. Check condition of batteries by depressing METHANE SAMPLE and BATTERY VOLTAGE buttons simultaneously. If pointer does not register in green area; Batteries must be recharged. Release both buttons.

Step 2. Depress METHANE SAMPLE button and hold instrument in area to be tested.

Step 3. Keep Sample button depressed and observe meter indication when pointer comes to rest. Keep SAMPLE button depressed 20-40 seconds before terminating test to insure complete stabilization and presence of a representative sample.

NOTE

If meter pointer fails to deflect momentarily when "SAMPLE" button is depressed, the instrument may be inoperative. Refer to Troubleshooting Section 6.0 Steps 1 & 2.

Step. 4. Terminate Test by releasing SAMPLE button.

NOTE

The Lower Explosive Limit (L.E.L) of Methane in air mixtures is 5.3%. A potentially dangerous concentration of methane therefore exists when the pointer indicates in the Red Scale area between 4 and 5 percent methane.

4.3 Electrical Zero Adjustment (Refer to Figure 6)

At least once a day, or upon installation of a different Sensor Cell, check electrical zero reading on fresh air (no combustibles). Use Operational Check procedure 4.1, Steps (a) through (c). Observe zero reading on meter when pointer stabilizes with SAMPLE button depressed. If pointer does not rest on zero; readjust as follows:

a. Loosen the retaining screw at the bottom of Power Pack Assembly with the 23-0977 Wrench provided and separate the two sections.

NOTE

IF METER POINTER DEVIATES FROM SCALE ZERO MORE THAN ONE FULL DIVISION, INSTRUMENT SHOULD BE RECALIBRATED. A DEVIATION OF 1/2 DIVISION IS NOT NECESSARILY CAUSE FOR RECALIBRATION. HOWEVER, IT WILL AFFECT THE READING OBTAINED BY AN EQUIVALENT PERCENTAGE OF GAS DETECTED SINCE THE SCALE IS LINEAR.

b. Use the screwdriver end of the wrench to adjust the ZERO Set Potentionmeter clockwise to move meter pointer upscale.

c. Make one quarter turn as a trail, then plug Detector into Power pack and recheck electrical zero. Repeat Steps (b) and (c) again if one quarter turn fails to achieve the proper amount of adjustment.

4.4 Calibration

The instrument is initially calibrated to indicate correctly on methane-air mixtures. With element aging, or Sensor Cell (23-0980) replacement, the calibration may drift and should be readjusted with the potentiometer marked "CALIBRATION". Use the following procedure to recalibrate the instrument.

a. Zero the instrument mechanically and electrically. Check battery voltage and recharge if necessary.
b. Position Test Cup (Code 23-1061) over Sensor Cell and supply 3% methane (CH^4) in-air at the rate of 1.5 to 2.0 cubic feet per hour (700 to 940 cc./min.).
c. Press the METHANE SAMPLE pushbutton, keep it energized, and note percent of methane indicated when meter pointer stabilizes.
d. If error in reading is noted, loosen the retaining screw at the bottom of Power Pack, and separate the two sections.
e. Use the screwdriver end of the Wrench to adjust the 'CALIBRATION" Potentiometer to indicate the actual test gas concentration. Turn Potentiometer clockwise to increase Meter reading.
f. Make on full turn as trial, and reconnect Detector and Power Pack Assemblies. Check Meter reading on 3% methane test gas again. If error in reading is noted; readjust "CALIBRATION" potentiometer until reading conforms to test gas concentration.
g. Remove Test Cup from Sensor Cell and purge Cell with methane-free air, then recheck electrical zero.

This test is to be performed as required for routine calibration or when Sensor Cell requires replacement.

4.5 Battery Charger 23-1046

The Battery Charger supplied for the Permissible Indicating Methane Detector is a device capable of delivering 22 ma at 14 VDC with input charging source at 115 VAC. The charge cycle for the Power Pack is 12 to 16 hours continuous depending upon the initial state of charge in the Battery Pack. The poser Pack should be recharged whenever the voltage test reading falls below the green index marker on the Meter Scale. To recharge the battery pack, proceed as follows:

a. Loosen the retaining screw at the bottom of the Power pack Assembly and separate the two sections.
b. Install the interconnecting cable between Charger 23-1046 and the socket marked "CHANGE" on the power Pack Assembly.
c. Plug the Charger line cord into a 115 VAC, 60 Hz. Source.

The charge rate is low enough so that the batteries may be left on charge for longer periods than the prescribed 12 to 16 hours.

In some applications it may be desirable to keep a spare Power Pack on hand, charged and ready for immediate use.

5.0 MAINTENANCE

Hand-Held Methane Detector

The Hand-Held methane Detector, like any precision testing device, is subject to normal wear, but proper care and periodic maintenance will extend the full useful life of the instrument.

5.1 Daily Maintenance Schedule

a. Remove any accumulation of material around the Sensor Cell.
b. Clean the porous metal housing of the Sensor Cell with low pressure air from an aspirator bulb.

CAUTION

DO NOT USE COMPRESS-AIR AS THIS MAY DAMAGE THE SENSING ELEMENTS OR CLOG THE POROUS HOUSING.

c. Check mechanical zero of meter with instrument in vertical position.
d. Always electrically zero the instrument on fresh air (no trace of combustibles).
e. Recharge Power Pack whenever voltage test reading falls below green index mark on the scale.

5.2 Component Replacement

Sensor Cell should be replaced if the following symptoms exist.

a. Meter cannot be set to scale zero within range of Potentiometer ZERO adjustment.
b. Meter cannot be set to correct test gas concentration (3% methane in air) within range of CALIBRATION Potentiometer adjustment.
c. Meter pointer does not come to zero within a reasonable time in fresh air after "SAMPLE" button is pressed.

If Sensor Cell is to be replaced, remove screws holding retaining Plate (23-1027) to Detector Assembly. Unplug complete Cell and replace with new one. The instrument must be rezeroed electrically and recalibrated in accordance with Sections 4.3 and 4.4 before using.

THE COLORIMETRIC CARBON MONOXIDE TESTER

The heart of the Colorimetric Carbon Monoxide Tester is a replaceable indicator tube in which is contained a yellow silica gel impregnated with different chemicals.

In use the sealed ends of a detector tube are broken and the tube is inserted in the Tester's tube holder. A sample is then drawn into the tube by squeezing the aspirator bulb. When the air sample carbon monoxide, the yellow silica gel turns to a shade of green. The darker the shade of green the higher the concentration of carbon monoxide.

Mounted directly beside the detector tube is a revolving color scale. The varying shades of green shown on the scale are easily distinguishable and the comparable carbon monoxide concentrations which they indicate are clearly marked in percentages. A flick of the finger brings the shades successively into position for quick, easy comparison with the discoloration in the detector tube.

The Tester is capable of indicating the presence of carbon monoxide in air from 0.001 to 0.10 percent by volume. A guard chemical contained within each indicator tube removes water vapor, gasoline vapor, and other interfering substances ordinarily encountered with carbon monoxide. One squeeze of the Tester's suction bulb is recommended to obtain an accurate indication of carbon monoxide concentration in the range of 0.005 to 0.10 percent. Greater sensitivity may be obtained by increasing the number of aspirations to two or five. The detector tube's function remains unimpaired even after extended storage.

To prepare the instrument for use:

1. Break both ends of a detector tube by using the hole provided for this purpose at the end of the scale mounting barrel.
2. Slip either end of the tube through the frame guide and insert it into the bushing at the head of the aspirator bulb.
3. Place the spring actuated retaining head over the free end of the tube and press lightly. This insures an airtight fir at the bushings.
4. Adjust the sliding scale until the zero is in line with the edge of the yellow stained chemical in the detector tube. The yellow turns brown when subjected to CO.

Testing for carbon monoxide:

1. There are three scales on the instrument calibrated in parts-per-million by volume (PPM).
2. The one-squeeze scale reads concentration from 0 to 2000 PPM.
    a. Place the inlet end of the instrument in the atmosphere to be tested.
    b. Suddenly and forcibly squeeze the aspirator bulb.
    c. Release the bulb. Hold it loosely by allowing it to expand completely be itself.
    d. Read the concentration of carbon monoxide.
        (1) Recheck to insure that the zero on the scale is in the correct position.
        (2) Obtain a value from the scale corresponding to the length of brown stain on the yellow graduals.
        (3) If the stain is uneven, read midway between the longest and the shortest extension of the stain.
3. The two-squeeze scale reads concentrations from 0 to 1000 PPM.
    a. Squeeze the aspirator bulb, at an interval of about 10 seconds.
    b. use the same procedure for reading as in 2c.
4. The six-squeeze scale reads concentrations from 0 to 250 PPM.
    a. Squeeze the aspirator bulb six times at intervals of about 10 seconds.
    b. Use the same procedure for reading as in 2c. **Note:** a double squeeze is more accurate that a single squeeze. The six squeezes are more accurate than the two squeezes.
5. To sample from a remote location:
    a. Insert the metal connecting tube into the instrument frame where the detector tube normally should go.
    b. Attach the sampling line to the connecting insert.
    c. Insert the detector tube into the sampling line.

CARBON MONOXIDE INDICATOR TUBES

INTRODUCTION

A carbon monoxide test is made by depressing, then releasing the Push button on the precision-built Universal Gas Sampler, thus drawing a controlled sample of air through the glass Indicator Tube. The flame seated ends are broken open just prior to use. The Indicator Tube contains yellow colored potassium-pallado-sulfite which reacts with carbon monoxide to yield a brownish stain of exceptional readability and contrast.

Stain length is proportional to the concentration of carbon monoxide. Parts per million and percent carbon monoxide by volume in air sample tested are read directly from the Scale.

Using Both Ends of Tube

EVERY INDICATOR TUBE IS GOOD FOR TWO TESTS, ECEPT WHERE LARGE CARBON MONOXIDE CONCENTRATION RESULTS IN LONG STAINS. At concentrations normally encountered the tube can be reversed after being stained on one end to use the unstained end for the next measurement. If the first test does not stain the gel the same end of the tube may be used for the next test.

Capping Tube

Stained Indicator Tubes can be preserved for later examination by capping both ends with the Tube Caps provided. As long as there is unstained yellow gel between the stains on both ends of the tube the reading will not be affected. A tube stained on one end only can be capped and used on the other end for testing up to 6 hours later.

Application of CO Indicator Tube

In testing, for carbon monoxide, the user should allow for the fact that while a test at a given location may show some carbon monoxide which in not in the dangerous concentration region, a test taken at or near the source of the carbon monoxide may show substantially higher concentrations. Accordingly, it is well in all cases to locate the source of carbon monoxide when its presence is established.

There are many federal, state and local ordinances, rulings and regulations pertaining to permissible concentration of carbon monoxide. Accordingly, the customer is advised in all cases to consult these authorities relative to the maximum permissible concentration and exposure.

Air Hygiene Testing

Carbon monoxide is a colorless, odorless gas, when inhaled it can cause poisoning ranging in severity from mild headache and nausea, to death. The degree of poisoning which results from exposure to carbon monoxide will depend on a multitude of factors, including: concentration of carbon monoxide, time of exposure, pressure of carbon monoxide laden air, individual basal metabolism, and the

individual's resistance to effects of carbon monoxide. Simply stated however, as the concentration of carbon monoxide increases the safe exposure time to carbon monoxide is decreased.

It has generally been accepted among health and safety testing experts that exposure to concentrations in excess of .01% (100 parts per million) for 8 hours should be avoided. More recently, the ACGIH (1967) has recommended 50 ppm as the time-weighted average for 8 hours exposure.

Combustion Testing

American Gas Association in their booklet "Suggested Safe practices When Installing and Servicing Gas Appliances" recommend that the percent carbon monoxide in flue gases from properly vented furnaces and boilers shall not exceed .04% (400 parts per million) on an air free basis. This would be equivalent to .03% (300 parts per million) carbon monoxide as measured in the flue. The American Gas Association recommends not over .02% (200 parts per million) carbon monoxide in flue products from properly vented water heaters. This will be equivalent to about .015% carbon monoxide (150 parts per million) as measured in the flue.

In all cases involving the testing of gas fired appliances or heating equipment for carbon monoxide in the flue gases, it is recommended that the used consult the local utility, since may of these utilities will have special regulations applying to such testing.

CARBON DIOXIDE INDICATOR TUBES

INTRODUCTION

Carbon dioxide test is always conducted with Stop Nut on Universal Gas Sampler in 50 cc position (flange up) and Orifice Assembly B installed. Measuring range is 0.1 to 4% CO_2. with 4 Pump Stroke portion of scale and .05 to 2% CO_2 with 8 Pump Stroke portion. The resulting measuring range permits evaluation CO_2 concentrations of interest to industrial hygienists and safety personnel.

Threshold Limit Value for carbon dioxide for an average 8 hour exposure as established by the American Conference of Governmental Industrial Hygienists (1965) is 0.5% (5000 ppm).

TUBE STORAGE PRECAUTIONS

Ambient temperature storage life stamped on CO_2 Tube Carton is 6 months from date of shipment. Shelf life under refrigeration (35^o to 40^o F) is at least one year. Shelf life in frozen storage (0^o F) is extended to two years. IT IS STRONGLY RECOMMENDED THAT CO_2 TUBES BE STORED REFRIGERATED UNTIL READY TO USE.

OPERATING PROCEDURE

1. BEFORE PROCEEDING, CHECK TO SEE THAT:
   (a) ORIFICE ASSEMBLY B IS INSTALLED AND KNURLED CLAMP NUT IS FINGER TIGHT.
   (b) STOP NUT IS IN 50 cc POSITION (FLANGE UP).
   (c) CO_2 SCALE 19-0090 IS INSTALLED.
2. Unfold Scale Frame and swivel forward until it locks in place.

3. Slide metal Tip Breaker on bottom of Universal Gas Sampler back to open tube breaker hole.
   Insert Indicator Tube tip in exposed hole and break off tips to open both ends of tube.
4. Insert Indicator Tube tip snugly into rubber Tube Connector of Sampler.
5. Depress Push button of travel and hold down for several seconds. Release Push Button quickly, and allow to return to original position. This will be shown by complete appearance of red line on Push Button.
6. When red line on Push Button is completely visible, take three more pump strokes for a total number of four. Make certain the red line is completely visible before depressing Push Button for succeeding strokes.
7. After fourth pump stroke, wait 30 seconds after red line is visible before examining Carbon Dioxide Indicator Tube.. White stain on dark blue colored gel indicates carbon dioxide.

READING CARBON DIOXIDE INDICATOR TUBE

(a) Slide Scale out as illustrated, until only UNSTAINED dark blue colored gel appears in the short scale slot (A) to the left of Scale's zero bar (B), and only stained gel appears in the long scale slot. "Stained" gel includes all dark blue reactive gel visibly lightened by carbon dioxide. "Unstained" gel is that portion of dark blue reactive gel which is totally unaffected by carbon dioxide (end opposite stain).

(b) Read Scale at junction (C) of stained gel and retaining screen. For maximum accuracy, rotate Indicator Tube approximately 90^{o} to four positions and average readings.

NOTE: Indicator Tube in illustration indicates .5% carbon dioxide on 4 PUMP STROKE portion of Scale.

If greater sensitivity is desired, four additional pump strokes for a total of eight may be taken. Resulting stain is read using the .05 to 2% range, 8 PUMP STROKE portion of Scale.

USING BOTH ENDS OF TUBE

EVERY INDICATOR TUBE IS GOOD FOR TWO TESTS, EXCEPT WHERE HIGH CARBON DIOXIDE CONCENTRATION RESULTS IN LONG STAIN. At concentrations normally encountered the Indicator Tube can be reversed after being stained on one end to use the unstained end for the next measurement. If the first test does not stain the gel, the same end of the Indicator Tube may be used for the next test.

CAPPING TUBE

Stained Indicator Tubes can be preserved for later examination by capping both ends with Tube Caps provided with the Universal Gas Sampler. A tube stained on one end only can be capped and used on the other end for testing up to several days later.

CARBON DIOXIDE TOXICITY DATA

Because of the paralyzing effect of high concentrations of carbon dioxide on the respiratory system, it is considered an industrial hazard. It appears as a byproduct of respiration and is likely to collect in

confined working spaces such as bats, tanks, ship's holds and manholes. Carbon dioxide combustion, and may also be found in blasting areas. This colorless, odorless gas is potentially hazardous in poorly ventilated spaces adjoining dry ice bunkers or where carbon dioxide is employed in the liquid state.

In the mining industry a relatively large proportion of carbon dioxide, accompanied by a depletion of oxygen, is known as blackdamp.

Since carbon dioxide regulates the respiratory cycle, increases in concentration breathed cause an increase in respiration leading to a condition known as hyperventilation. Asphyxiation and death result from further increases in carbon dioxide which eventually paralyzes the respiratory center.

Although increasing levels of carbon dioxide are usually accompanied by a deficiency of oxygen, definite physiological responses may be attributed to the gas itself.

Table I was constructed from values appearing in "The Analytical Chemistry of Industrial Poisons, Hazards, and Solvents" by Morris B. Jacobs.

TABLE I

% CO_2 CONCENTRATION	Physiological Effect
0.5	Threshold Limit Value, Imperceivable increase in lung ventilation.
2.0	Lung ventilation increases approximately 50%.
3.0	Lung ventilation increases approximately 100%.
5.0	Ventilation increases 300%, and breathing becomes laborious.
10.0	Can be endured only a few minutes.
12.15	Rapid unconsciousness.

CARBON DIOXIDE INDICATOR TUBE DATA

INTERFERING GAS INFORMATION

Bacharach Carbon Dioxide Indicator Tubes are not affected by humidity, or gases and vapors in concentrations generally encountered in industrial safety and air hygiene testing. Effect of interfering gases will be negligible since these gases will be negligible since these gases are not generally present in the comparatively high concentration of interest when making carbon dioxide determinations.

Interfering gases include all acid gases such as hydrogen sulfide, oxides of nitrogen, sulfur dioxide, and acid fumes. Halogen gases also interfere. 1000 ppm of an interfering gas would affect the reading noticeably if measured in the presence of .5% (5000 ppm) CO_2.

INDICATOR TUBE DESITY CORRECTION

If significant, Indicator Tube reading may be corrected for Universal Gas Sampler volume variations caused by difference in existing gas density as compared with calibration conditions.

$$\text{INDICATOR TUBE READING} \times \frac{29 \text{ in. Hg}}{P_a} \times \frac{460O + T_a}{520^o \text{ R}} = \text{CORRECTED INDICATOR TUBE READING}$$

where,

P_a = Existing barometric pressure (in. Hg.)
T_a = Existing temperature (^{o} F)

SUPPLEMENTARY INSTRUCTIONS

Please refer to Instructions 19-9053 for additional information pertaining to Universal Gas Sampler maintenance. Use of remote sampling assemblies, and Spare Parts List.

MONOXOR CARBON MONOXIDE DETECTOR

If, after one pump stroke, the stain forms only at the edge of the gel the concentration is approximately 300 parts CO per million parts of air, but the CO concentration is much higher if the stain extends over the entire length of the gel.

If no stain appears after the first pump stroke, but a definite stain develops after the second stroke it is an indication that the carbon monoxide concentration in the sample is in the range of 100 to 300 parts CO per million parts of air.

No appearance of any stain after two pump strokes is an indication that the carbon monoxide concentration is less than 100 parts CO per million parts of air.

THE MSA HYDROGEN SUPHIDE DETECTOR

Description

The MSA Hydrogen Sulphide Detector is a hand-held instrument used for the detection of hydrogen suphide. This instrument has been approved by the U.S. Bureau of Mines.

Inspection

Before the MSA hydrogen Sulphide Detector is used, preliminary checks must be conducted. These checks are to ensure that the instrument is functioning properly and accurate measurements are obtainable.

1. Inspect the aspirator to see that it is in good condition and fits tightly on the metal tube extending from the valve housing.
2. Inspect the condition of the valves to ensure they are operating freely and do not leak.
   a. The outlet valve.
      (1) The outlet valve may be tested by depressing the bulb and holding a finger over the rubber seat into which the detector tube is to be inserted.

(2) If the bulb remains deflated, the out-valve is in proper operating condition and is not leaking.

b. The inlet valve.
   (1) The inlet valve may be tested by placing a finger over the opening of the outlet valve and squeezing the bulb.
   (2) This should cause the inlet valve to seat tightly and make it impossible to force the air from the bulb.

c. Leaky valves.
   (1) In the event the valves leak, they should be removed and cleaned.
   (2) After cleaning, recheck the valves prior to use.

Operation

Preparation of the Instrument for Use

1. Break both ends of a detector tube. Use the hole provided for this purpose at the base of the instrument frame.
2. Slip the colored end of the tube through the frame guide and insert it into the bushing at the head of the aspirator bulb.
3. Place the spring actuated retaining head over the free end of the tube and press lightly. This is to ensure that a snug, airtight fit is obtained at the bushings.
4. Adjust the sliding scale unit the zero is in line with the edge of the granular material in the detector tube.

Testing for hydrogen Sulphide

1. Place the inlet end of the instrument in the atmosphere to be tested.
2. Squeeze the aspirator bulb suddenly and forcibly.
3. Release the bulb, hold it loosely, and allow it to expand completely by itself.
4. Squeeze and release the bulb in a like manner **ten times**. This is necessary in order to obtain a complete chemical reaction in the detector tube.
5. Read the concentration of hydrogen sulphide.
   a. Recheck to ensure that the zero on the scale is in the correct position.
   b. Obtain a value from the scale corresponding to the length of stain on the white granules. **If the stain is uneven, read midway between the longest and shortest extension of the stain.**
6. To sample from a remote location:
   a. Insert the metal connecting tube into the instrument frame, where the detectors tube is normally placed.
   b. Attach the sampling line to the connecting insert.
   c. Insert the colored end of a detector tube into the sampling line.
   d. Remove the detector tube from the sampling line and insert it into the instrument.

NOTE: To convert readings of scale from parts per million (p.p.m.) to percent by volume, move decimal point 4 places to left.

Example: 25 p.p.m. = 0.0025 percent.

MAINTENANCE

This is a relatively rugged instrument and requires little maintenance. However, if the following listed items are performed, it will ensure a prolonged instrument life.

1. Keep the detector in the case when not in use.
2. Store in a cool, dry place.
3. The inlet and outlet control valves should be protected from dust and liquids.
4. The instrument should be examined periodically to ensure proper performance.

OTHER USEFUL INFORMATION

GENERAL

The hydrogen sulphide detector is a scientific instrument and should be handled with care to ensure proper operation. Super-sensitive hydrogen sulphide detectors are also available which are capable of indicating concentrations between 0 and 50 parts per million or between o and 3 grains per 100 cubic feet of gas. (**NOTE:** These supersensitive instruments require special tubes and scales).

The glass testing tube used in the instrument contains white granules of alumina impregnated with silver cyanide. In the presence of hydrogen sulphide the granules turn to a gray color.

Specifics

Effects of temperature light, and other gases on the hydrogen sulphide detector:

1. Temperature
    a. Temperature has little or no effect upon the operation of the detector.
    b. It has been operated satisfactorily at temperatures ranging from –7.6 degrees to 77 degrees Fahrenheit.
2. Light
    a. Light appears to have no undesirable effect upon the detector tubes.
    b. After eighteen months of storage in ordinary laboratory daylight, detector tubes retain their sensitivity.
3. Gases

It has been found that the following gases and vapors do not produce a color change in the detector tubes:

a. Carbon monoxide
b. Carbon dioxide
c. Sulphur dioxide
d. Chlorine
e. Hydrochloric acid
f. Natural gas
g. Gasoline
h. Benzol
i. Ethyl alcohol
j. Methyl alcohol

MSA HYDROGEN SULPHIDE DETECTOR

1. What is the MSA hydrogen Sulphide Detector?
2. Since this instrument is designed for underground use, can it be considered a rugged instrument?
3. What is the first preliminary instrument check?
4. What is the second preliminary instrument check?
5. What is the first step in preparing the instrument for use?
6. What is the second step in preparing the instrument for use?
7. What is the third step in preparing the instrument for use?
8. What is the fourth step in preparing the instrument for use?
9. What is the first step when testing for hydrogen sulphide?
10. What is the second step when testing for hydrogen sulphide?
11. What is the third step when testing for hydrogen sulphide?
12. What effect does temperature have upon the indications of this detector?
13. What effect does light have upon the indication of this indicator?
14. What effect do gases have upon the indication of this detector?
15. When the detector is not in use, how should it be carried?
16. When the detector is not in use for an extended period of time, where should it be stored?
17. When stored, should protection be afforded for the inlet and outlet valves?
18. When stored, should the instrument be tested periodically?

THE NITROGEN DIOXIDE DETECTOR

The MSA Nitrogen Dioxide Detector is a hand-held, manual instrument used for the detection of nitrogen dioxide in the mining atmosphere. It will indicate concentrations from 0.5 to 50 parts per million.

Inspection

Before the MSA Nitrogen dioxide Detector is used, preliminary checks must be conducted. These checks are to ensure that the instrument is functioning properly and accurate measurements are obtainable.

1. First, inspect the bulb to see that it is in good condition and fits tightly on the metal tube extending from the valve housing.
2. Next, inspect the operational condition of the valves to ensure that they are operating freely and do not leak.
    a. The outlet valve.
        (1) The outlet valve may be tested by depressing the bulb and holding a finger over the rubber seat into which the detector tube is to be inserted
        (2) If the bulb remains deflated, the outlet valve is in proper operating condition and not leaking.
    b. The inlet valve.
        (1) The inlet valve may be tested by placing a finger over the opening of the outlet valve and squeezing the bulb.
        (2) This should cause the inlet valve to seat tightly and make it impossible to force the air from the bulb.
    c. Leaky valves.
        (1) In the event the valves leak, they should be removed and cleaned.
        (2) After cleaning, recheck the valves prior to use.

Operation

Preparation of the instrument for use is done as follows:

1. Break off both ends of a detector tube.
    a. The breaking point at one end has a scored mark about 1 1/2 inches from the end. Discard the short, blunt-end length of the tube which contains the brown substance.

CAUTION: Do not break this end open since the brown substance is poisonous and irritating to the skin.

    b. The other end of the tube should be broken by using the tube breaker hole at the end of the scale mounting barrel.
2. Slip the tapered end of the tube through the frame guide and insert it into the bushing at the head of the aspirator bulb.
3. Place the spring actuated retaining head over the free end of the tube and press lightly. (This is to ensure that a snug, airtight fit is obtained at the bushings).
4. Adjust the sliding scale until the zero is in line with the edge of the granular material in the detector tube.

Testing for Nitrogen

1. There are two scales on the instrument; both scales are calibrated for concentrations of gas in parts per million per volume.
2. The one squeeze scale.
    a. Reads concentration from 0 to 50 p.p.m.
    b. Place the inlet end of the instrument in the atmosphere to be tested.
    c. Squeeze the aspirator bulb suddenly and forcibly.
    d. Release the bulb, hold it loosely, and allow it to expand completely by itself.
    e. Read the concentration of nitrogen dioxide.
        (1) Recheck to ensure that the zero on the scale is in the correct position.
        (2) Obtain a value from the scale corresponding to the length of stain on the stain, on the white granules. (If the stain is uneven, read midway between the longest and shortest extension of the stain).
3. The three squeeze scale.
    a. This scale is more accurate than the one squeeze scale. It reads concentrations of gas from 0 to 10 p.p.m.
    a. The same procedure is used as that for the one squeeze scale, except three squeezes are mad on the aspirator.
    b. The same procedure for reading is used, but it is taken from the three squeeze scale.
4. Since the odor threshold of NO_2 is about the level of the recommended maximum allowable concentration of 5 p.p.m., monitoring of suspected atmospheres is important. 1/1/A's adopted by American Conference of Governmental Industrial Hygienists, 1959.
5. To sample from a remote location.
    a. Insert the metal connecting tube into the instrument frame (where the detector tube normally goes).
    b. Attach the sampling line to the connecting insert.
    c. Insert the tapered end of a detector tube into the sampling line.
    d. Use the above procedure for 3b or 3c to obtain the stained granules.
    e. Remove the detector tube from the sampling line and insert it into the instrument.
    f. Read the concentration of nitrogen dioxide as outlined above in 3a.

Maintenance

This instrument is relatively rugged and requires little maintenance. However, to ensure prolonged instrument life, the following procedures should be performed:

1. When not in use, keep the detector in the case.
2. Store in a cool, dry place.
3. The inlet and outlet control valves should be protected from dust and liquids.
4. The instrument should be examined particularly to ensure proper performance.

MSA NITROGEN DIOXIDE DETECTOR

1. What is the MSA Nitrogen Dioxide Detector?

2. Since this instrument is designed for underground use, can it be considered a rugged instrument?

3. What is the first preliminary instrument check?

4. What is the second preliminary instrument check?

5. What is the first step in preparing the instrument for use?

6. What is the second step in preparing the instrument for use?

7. What is the third step in preparing the instrument for use?

8. What is the fourth step in preparing the instrument for use?

9. What is the first step when testing for nitrogen dioxide?

10. What is the second step when testing for nitrogen dioxide?

11. What is the third step when testing for nitrogen dioxide?

12. When the detector is not in use, where should it be stored?

13. When the detector is not in use, where should it be stored?

14. When stored, should protection be provided for the inlet and outlet valves?

15. When stored, should the instrument be tested periodically?

ANSWER SHEET FOR
MSA HYDROGEN SULPHIDE DETECTOR

1. A device used for accurately indicating the concentration of hydrogen sulphide in the mine atmosphere.
2. Although it is for mine use, it is a scientific instrument and must be handled with care.
3. Inspect the aspirator to see that it is in good operating condition.
4. Inspect the operational condition of the valves to ensure that they are operating freely and do not leak.
5. Break both ends of a detector.
6. Slip the colored end of the tube through the frame guide and insert it into the bushing at the head of the aspirator bulb.

7. Place the spring actuated retaining head over the free end of the tube and press lightly.
8. Adjust the sliding scale until the zero is in line with the edge of the granular material in the detector tube.
9. Place the inlet end of the instrument in the atmosphere to be tested.
10. Squeeze and release the bulb **ten times**.
11. Read the concentration of hydrogen sulphide as indicated on the detector tube.
12. Little or none.
13. No apparent effect.
14. The ten gases listed in this course have no effect.
15. In the case provided.
16. In a cool, dry place.
17. Yes! They should be protected from dust and liquids.
18. Yes! This will ensure proper performance

ANSWER SHEET FOR
MSA NITROGEN DIOXIDE DETECTOR

1. A device used for accurately indicating the concentration of nitrogen dioxide in the mine atmosphere.
2. Although it is for mine use, it is a scientific instrument and must be handled with care.
3. Inspect the bulb to see that it is in good operating condition.
4. Inspect the operational condition of the valves to ensure that they are operating freely and do not leak.
5. Break off both ends of a detector tube.
6. Slip the tapered end of the tube through the frame guide and insert it into the bushing at the head of the aspirator bulb.
7. Place the spring actuated retaining head over the free end of the tube and press lightly.
8. Adjust the sliding scale until the zero is in line with the edge of the granular material in the detector tube.
9. Place the inlet end of the instrument in the atmosphere to be tested.
10. Squeeze suddenly and forcibly and release the bulb.
11. Read the concentration of nitrogen dioxide as indicated on the detector tube.
12. In its designated case.
13. In a cool, dry place.
14. Yes. They should be adequately protected from dust and liquids
15. Yes, to ensure proper performance.

CHAPTER TEN

FIRST AID

1. First Aid
2. Anatomy
3. Respiration
4. Control of Bleeding
5. Physical Shock
6. Wounds and Burns
7. Dislocations and Fractures
8. Transportation of the injured.
9. Sample Questions for First Aid

FIRST AID

1. What is first aid?
2. Name the six (6) fundamentals of first aid in order of their importance.
3. What first aid equipment shall be provided at a mine?
4. Where shall first aid material be kept?

ANATOMY

5. Into what three parts is the body divided?
6. What is the skeleton?
7. What is the composition of the skeleton?
8. What is the purpose of the skeleton?
9. What is the skull?
10. What bones form the trunk?
11. What is the spinal column?
12. What is the function of the spinal column?
13. How many ribs are on each side of the chest?
14. What is the pelvis?
15. Of what does each upper extremity consist?
16. What three bones form the shoulder joint?
17. How many bones are in each upper arm?
18. How many bones are in the forearm?
19. How many bones are in the wrist?
20. How many bones are in the hand?
21. How many bones are in the fingers of each hand?

22. Of what does each lower extremity consist?
23. How many bones are in the thigh?
24. How many bones are in the leg?
25. How many bones form the kneecap?
26. How many bones are in the ankle?
27. How many bones are in the foot?
28. How many bones are in the toes of each foot?
29. What is a joint?
30. How are the bones forming a joint held in position?
31. What are muscles?
32. What causes movement of the body?
33. What are tendons?
34. What is the purpose of tendons?
35. What is the skin?
36. What are some of the functions of the skin?
37. What protection is provided by the skin?
38. What is infection?
39. What divides the trunk into two parts?
40. What are the upper and lower portions of the trunk commonly called?
41. What organs are contained in the chest cavity?
42. What organs are contained in the abdominal cavity?
43. What are the principal organs of the excretory system?

RESPIRATION

44. What is the first fundamental of first aid?

45. What is meant by respiration?

46. What are the air passages?

47. What prevents food or liquid from entering the windpipe?

48. How may the epiglottis of an unconscious person be prevented from opening to admit air.

49. What is the first thing to be done with the tongue of an unconscious person when breathing is obstructed or absent?

50. How does the windpipe divide?

51. What are the lungs?

52. How is the blood purified in the lungs?

53. What is the normal rate of breathing for healthy persons?

54. What is artificial respiration?

55. How is artificial respiration accomplished?

56. When should artificial respiration be given?

57. When should artificial respiration be started?

58. How long should artificial respiration be continued?

59. What accidents may require artificial respiration?

60. What precautions must be taken before starting artificial respiration?

61. What additional treatment is necessary while giving artificial respiration?

62. What stimulant should be given during artificial respiration and by what means?

63. What are the commonly used methods of artificial respiration?

64. Which method of artificial respiration is usually preferable?

65. How many times per minute should the patient be caused to breathe while giving artificial respiration?

66. What is the position of the patient in the Holger-Nielson method of artificial respiration?
67. How is the Holger-Nielson method of artificial respiration given?
68. What is the position of the patient in the Schaefer method of artificial respiration?
69. How is the Schafer method of artificial respiration given?
70. What is the position of the patient in the Sylvester method of artificial respiration?
71. How is the Sylvester method of artificial respiration given?
72. What additional treatment may be given to assist artificial respiration?
73. How does electricity cause shock?
74. What are the symptoms of electric shock?
75. What precautions should be taken in rescuing a person from contact with a live wire?
76. What is a good method of pulling a person from contact with a live wire?
77. How can a live wire be short-circuited when a person is in contact?
78. What treatment should be given a person suffering from electric shock?
79. How may gas poisoning be prevented?
80. What treatment should be given a person suffering from suffocation or gas poisoning?

CONTROL OF BLEEDING

81. What is the second fundamental of first aid?
82. What is the circulatory system?
83. What is blood?
84. What is the function of the blood?
85. What proportion of the body, by weight, is composed of blood?
86. What is the heart?
87. Where is the heart located?
88. What is the function of the heart?
89. What is the rate at which the heart contracts or beats normally?
90. What are the several types of blood vessels?
91. What is the function of the arteries?
92. What is the function of the veins?
93. Where may the pulse beat rate be examined conveniently?
94. What is hemorrhage or bleeding?
95. What are the symptoms of arterial bleeding?
96. What are the symptoms of venous bleeding?
97. What are the symptoms of capillary bleeding?
98. Why is bleeding dangerous?
99. What is nature's method of stopping bleeding?
100. Who are bleeders?
101. Name the method of controlling bleeding?
102. How should the flow of blood be stopped from a wound in case of capillary bleeding?
103. How should the flow of blood be stopped from a would in a case of venous bleeding?

104. How should the flow of blood be checked from a wound in a case of arterial bleeding?

105. Why should digital pressure be applied before the tourniquet?

106. Where should digital pressure be applied to check arterial bleeding?

107. What is meant by pressure points?

108. How many pressure points are there?

109. What is a tourniquet?

110. What precaution should be observed when a tourniquet is applied?

111. How long should a tourniquet remain tight over a pressure point?

112. What is likely to occur when a tourniquet is not loosened every ten (10) minutes?

113. Where are the pressure points for a wound of the scalp?

114. Where is the pressure point for a wound of the face or nose?

115. Where is the pressure point for wound of the armpit or for arm torn from the body?

116. Where is the pressure point for wound of the upper arm?

117. Where are the pressure points for a wound of the forearm?

118. Where are the pressure points for wound of the hand?

119. Where is the pressure point for a wound of the groin?

120. Where are the pressure points for a wound of the thigh?

121. Where is the pressure point for a wound of the lower leg?

122. What may be used for a tourniquet?

123. What are the symptoms of internal hemorrhage?

124. What is the treatment for internal hemorrhage?

125. Should internal stimulants be given in case of internal hemorrhage?

PHYSICAL SHOCK

126. What is the third fundamental in first aid?

127. What is the function of the nervous system?

128. What is the sympathetic nervous system?

129. What does the sympathetic nervous system control?

130. What is physical shock?

131. What causes physical shock?

132. Why is it essential to give treatment for physical shock after many injuries?

133. When should treatment for physical shock be started?

134. How long should treatment for physical shock be continued?

135. What is the appearance of the face and condition of the skin in case of physical shock?

136. What is the condition of the eyes in case of physical shock?

137. What is the condition of breathing in case of physical shock?

138. What is the condition of the pulse in case of physical shock?

139. What is the general condition of the patient in case of physical shock?

140. What may be the effect of physical shock on the digestive system?

141. What is the treatment for physical shock?

142. Under what conditions of physical shock would it be improper to place the patient's head low?

143. Under what conditions would it be improper to give a stimulant to a patient who is suffering from physical shock?

144. What may be used for heat applications?

145. What precaution should be taken with heat application to avoid burning patient?

146. What substances or materials may be used for a liquid stimulant?

147. What quantities of aromatic spirits of ammonia should be given as a stimulant?

148. How should a liquid stimulant be administered?

149. When should a liquid stimulant be given in case of physical shock?

150. How may stimulants be given if patient is unconscious?

151. In what condition where physical shock is present should the patient not be kept warm?

152. What causes sunstroke?

153. What are the symptoms of sunstroke?

154. What first aid treatment should be given for sunstroke?

155. What is apoplexy?

156. What are the symptoms of apoplexy?

157. Describe the treatment for apoplexy.

158. What stimulants or emetics may be given to persons suffering from apoplexy?

159. What is fainting?

160. What are the symptoms of fainting?

161. What is the treatment for fainting?

162. What is heat exhaustion?

163. To what other ailment are the symptoms of heat exhaustion similar?

164. What other ailment is the treatment for heat exhaustion similar?

165. For what physical conditions is it important to keep the head low?

166. For what physical conditions is it important to elevate the head?

167. What are heat cramps?

168. How may heat cramps be prevented?

WOUNDS AND BURNS

169. What is the fourth fundamental in first aid?

170. What is a wound?

171. What are the four (4) classifications of wounds?

172. What is an abrasion?

173. What is an incised wound?

174. What is a lacerated wound?

175. What is punctured wound?

176. Describe the general care of wounds.

177. What is the purpose of using sterile bandages?

178. How may loose foreign particles be removed from a wound?

179. Who should remove splinters or imbedded objects from a wound?

180. What is the first thing to be done with a wound when the bleeding is from an artery?

181. How should wounds be dressed?

182. Where should the knot bandage be tied in the case of a wound?

183. Under what conditions should the knot be tied in some other place than over the compress?

184. What is a burn?

185. What is a scald?

186. What is the general treatment for burns and scalds?

187. How should clothing be removed from a burn?

188. What product is generally used to treat burns and scalds?

189. Why should not grease or oil be used to dress burns and scalds?

190. Define picric acid gauze.

191. What precautions should be taken in treating burns?

192. How should dressings be applied to burns?

193. How should chemical burns be treated before applying dressings?

194. How should chemical burns of the eye be treated?

195. What bandages are used in first-aid work?

196. In general, how tight should bandages be applied?

197. How should a triangular bandage sling be placed?

198. What kind of knot is used in tying bandages?

199. What are bruises?

200. What are the symptoms of bruises?

201. What treatment should be given for a bruise?

202. Why should a bruise never be rubbed?

203. What is a strain?

204. How should a strain be treated?

205. What is a sprain?

206. What should be done where doubt exists whether a sprain, a dislocation, or a fracture is present?

207. What is a rupture or hernia?

208. What are the symptoms of rupture?

209. What is the first-aid treatment for rupture?

210. What is the treatment for foreign bodies in the eyes?

211. What is the treatment for foreign bodies in the ear?

212. What is the treatment for foreign bodies in the nose?

213. What is the treatment for foreign bodies in the throat or windpipe?

214. What is the treatment for foreign bodies in the stomach?

215. What is the treatment for bleeding varicose veins?

216. How should clothing be removed from an injured person?

DISLOCATIONS AND FRACTURES

217. What is the fifth fundamental of first aid?

218. What is a dislocation?

219. What other injury always accompanies a dislocation?

220. What are the symptoms of dislocation?

221. In general, how should a dislocation be treated?

222. What dislocations may the first-aid man reduce?

223. How should a dislocation of the finger be reduced?

224. How should dislocation of the lower jaw be reduced?

225. How should a dislocation of the shoulder be treated?

226. How should a straight dislocation of the elbow be splinted?

227. How should a bent dislocation of the elbow be splinted?

228. How should a dislocation of the hip be splinted?

229. How should a dislocation of the knee be splinted?

230. What is a broken back splint?

231. What is a fracture?

232. Name the two kinds of fractures treated in first-aid work.

233. Define a simple fracture.

234. Define a compound fracture.

235. What may happen when a simple fracture is improperly handled?

236. How may a simple fracture be converted into a compound fracture?

237. What are the symptoms of a fracture?

238. What precautions should be exercised in examining an injured person?

239. What precautions should be taken in the case of simple fracture to prevent compound fracture?

240. What kind of dressing should be used for a compound fracture?

241. In addition to dressing fractures and dislocations, what other treatment is necessary?

242. What are the symptoms of a fracture of the skull?

243. Is the patient conscious or unconscious when the skull is fractured?

244. What treatment is given for fracture of the skull with no open wound?

245. How should a compound fracture of the skull be dressed?

246. What are the symptoms of a fracture of the lower jaw?

247. What are the symptoms of a fracture of the collarbone?

248. How should a fracture of the collarbone be dressed?

249. How should a fracture of the shoulder blade be dressed?

250. How should a fracture of the upper 1/3 of the arm be dressed?

251. How should a fracture of the lower 2/3 of the arm be splinted?

252. How should a fracture of an elbow be splinted?

253. How should a fracture of the forearm be splinted?

254. How should a fracture of the wrist be splinted?

255. How should a facture of the hand be splinted?

256. What are the symptoms of fracture of the rib?

257. How should a fracture of the rib be treated and dressed?

258. What is the danger in a fracture of the spine?

259. What are the symptoms of fracture of the spine?

260. If the patient's back is bent at the point of a fracture of the spine, what should be done?

261. How should a fracture of the spine be splinted if the patient is in a straight position?

262. How many bandages are used to properly secure a patient to the splint in case of a broken neck?

263. How many bandages are used to properly secure a patient to the splint in case of a fractured spine?

264. How is the patient with a fractured spine placed on the splint?

265. What are the symptoms of fracture of the pelvis?

266. What is the danger of a fracture of the pelvis?

267. In case of a fracture of the pelvis, how can the danger of a puncture of the bladder be lessened?

268. How should a fracture of the pelvis be treated after the pelvis has been supported?

269. How should a compound fracture of the thigh with arterial bleeding be dressed?

270. How should a fracture of the kneecap be splinted?

271. How should a fracture of the leg or ankle be splinted?

272. How should a fracture of the foot or toes be splinted?

TRANSPORTATION OF THE INJURED

273. What is the sixth fundamental of first aid?

274. What is first aid?

275. What should be done when a person is injured?

276. What is the purpose of all men around the mine being well trained in first aid methods?

277. Why should men be retrained each year?

278. What precautions should a seriously injured person be moved?

279. In what position should a seriously injured person be moved?

280. What precautions should be taken before loading a man on a stretcher?

281. Which side is preferable to have the patient lifted when loading or unloading from stretcher?

282. When marching with stretcher, do all men keep in step?

SAMPLE QUESTIONS FOR FIRST AID

1. Blood is moved through the body in a series of large and small blood vessels, arteries, veins, and capillaries. How is the pressure supplied to circulate the blood?
    a. Movement of the body
    b. Body heat
    c. The concentration and expansion (pumping action) of the heart
    d. None of the above

2. Treatment for a skull fracture includes _____.
    a. Placing the patient's head lower than the rest of his body
    b. Applying cold compresses to the region of the fracture
    c. Placing the patient's head on the side of suspected fracture
    d. None of the above

3. Scalds result from _____.
    a. Fire
    b. Electricity
    c. Steam vapors or hot solution
    d. None of the above

4. What is the treatment for acids in the eye?
    a. Wash the eye out with base solution
    b. Wash the eye out with antiseptic
    c. Wash the eye out with water
    d. Wash the eye out with soapy water
    e. None of the above

5. When a victim has been revived and is breathing normally, they should be _____.
    a. Kept warm and quiet, (lying down), to avoid strain on their heart
    b. Stood up
    c. Administered a stimulant
    d. None of the above

6. When one rescuer performs CPR, the ratio of chest compressions to lung inflations for an adult victim is _____.
    a. 12 compressions to 2 ventilations
    b. 5 compressions to 1 ventilation
    c. 7 compressions to 1 ventilation
    d. 15 compressions to 2 ventilations

7. After opening the airway, if a rescuer sees chest movements in an unconscious victim, he/she should _____.
    a. Not initiate any CPR procedure
    b. Assume the victim is breathing
    c. Listen and feel for breathing with ear near victim's mouth
    d. Perform only chest compressions

8. The second step in removing an obstruction from an unconscious patient with an airway obstruction is to _____.
    a. Clean out the mouth and throat
    b. Position the head and jaw
    c. Force air into the lungs
    d. Perform the Holger-Nielson
    e. None of the above

9. One of the symptoms of a fractured back is _____.
    a. Partial or total paralysis
    b. Severe nosebleed
    c. Swelling in the lower legs
    d. None of the above

10. To determine whether or not an unconscious adult victim has a pulse, the rescuer should palpate the pulse _____.
    a. At the carotid artery in the neck
    b. At the femoral artery in the groin
    c. At the brachial artery in the arm
    d. At the radial artery in the wrist
    e. None of the above

ANSWER SHEET FOR
FIRST AID

1. The emergency car of an injured person before medical assistance is secured.
2. Artificial respiration, control of bleeding, physical shock, wounds and burns, fractures and dislocations, and transportation.
3. Two stretchers, two woolen and two waterproof blankets, and all necessary requisites for the first fifty men and one additional stretcher woolen blanket and waterproof blanket and necessary equipment for each additional fifty men.
4. One set at the surface and at strategic locations underground near the sections.

ANSWER SHEET FOR
ANATOMY

5. Head trunk and extremities.
6. The framework of the body.
7. A hard substance called bone.
8. It supports and protects the vital organs and gives attachment to the muscles.
9. A bony case, which encloses and protects the brain.
10. The spinal column ribs breastbone and pelvis.
11. The vertebrae extending from the cranium to the pelvic bone.
12. To give rigidity to the body and to protect the spinal cord.
13. Twelve (12).
14. A flat basin shaped bone at the lower portion of the trunk.
15. Collarbone, shoulder blade, arm, forearm, wrist, and hand.
16. The collarbone, shoulder blade, and upper arm bone.
17. One (1).
18. Two (2).
19. Eight (8).
20. Five (5).
21. Fourteen (14).
22. Thigh, kneecap, leg, ankle, and foot.
23. One (1).
24. Two (2).
25. One (1).
26. Seven (7).
27. five (5).
28. Fourteen (14).
29. Where two or more bones meet to form movement.
30. By strong ligaments of fibrous tissue.
31. The fleshy fibers which give shape to the body.
32. The lengthening and shortening of the muscles.
33. Tendons are strong white fibrous tissue.
34. To attach muscles to bone.
35. The protective covering of the body.

36. It contains the sense of touch and assists the body to get rid of heat and certain impurities.
37. Against infection.
38. The formation of poisonous products caused by the multiplication of germs or bacteria on exposed tissue.
39. The diaphragm.
40. The chest cavity and the abdominal cavity.
41. The gullet, windpipe, heart, lungs, and some large blood vessels.
42. The stomach, liver, spleen, pancreas, kidneys, bladder, and intestines.
43. The bowels, kidneys, lungs, and sweat glands.

ANSWER SHEET FOR RESPIRATION

44. Artificial respiration.
45. Inhaling air and exhaling impurities.
46. The nose, throat, and windpipe.
47. A flap at the top of the windpipe known as the epiglottis.
48. By the tongue falling pack into the throat.
49. Draw the tongue forward and hold it in that position.
50. Into the bronchi and subdivisions known as bronchial tubes.
51. Two soft elastic cone shaped bodies.
52. Carbon dioxide is exchanged for oxygen through the thin walls between the air cells and the blood.
53. About fifteen (15) times per minute.
54. A method by which normal respiration is imitated by manual means.
55. Air is forced from the lungs by compression and is drawn into the lungs when compression is released.
56. When there is little or no breathing.
57. As quickly as possible after the accident has occurred.
58. Until breathing is restored or until a physician declares the patient dead.
59. Electric shock, gas poisoning, suffocation, and drowning.
60. Remove foreign objects from mouth, see that tongue is forward and clothing is loosened.
61. The regular treatment for physical shock.
62. The fumes of aromatic spirits of ammonia by inhalation.
63. Mouth-to-mouth resuscitation, the Holger-Nielson, the Sylvester and the Schaefer or prone-pressure.
64. Mouth-to-mouth resuscitation.
65. Twelve (12) times per minute in the Holger-Nielson method and twelve (12) to fifteen (15) times per minute in the Sylvester and the Schaefer method.
66. The patient is placed face down with his elbows bent and his hands placed one upon the other under his head. Turn his head to one side.
67. Kneel on one or both knees in front of head of victim. Place the hands flat on the victims back just below the shoulder blade with the tips of the thumb just touching and the fingers spread. Rock forward until the arms are vertical, release the pressure, rock back slowly.
    Place your hands upon the patients arms just above the elbows, lift them firmly toward you, then lower them gently to the ground. Repeat procedure twelve (12) times per minute.

68. The patient is placed on his stomach, one arm extended straight over his head, the other bent to give a rest for his head.
69. The operator straddles the patient's thighs, the palms of the hands are placed at the small of the back, pressure is applied by swinging forward with arms held straight, pressure is released by swinging back.
70. The patient is placed on his back with arms at his side and pad under his shoulders.
71. The operator kneels above the patient's head, the arms are grasped at the wrist and pulled up and over his head, pressure is applied by bringing the arms down and crossing the forearms against the chest.
72. Administer oxygen.
73. By paralyzing the nerve centers that control breathing and the heart action.
74. Loss of consciousness, absent or weak respiration, weak pulse, and burns at the point of contact.
75. Disconnect or short circuit current, cut wire or use insulating material for protection when pulling victim away.
76. Stand on dry insulating material and use a loop of dry cloth.
77. By dropping a bar or wire on rail and wire on both sides of victim.
78. Remove the person from contact an start artificial respiration immediately.
79. By adequate ventilation and the use of protective equipment in poisonous atmospheres.
80. Remove the victim to pure air and start artificial respiration without delay.

ANSWER SHEET FOR CONTROL OF BLEEDING

81. The control of bleeding.
82. The heart, arteries, veins, and capillaries by which blood is circulated through the body.
83. A fluid called serum or plasma in which flats red and white corpuscles.
84. To carry nourishment and oxygen to the tissues, furnish heat and remove waste matter.
85. About one twelfth ($1/12^{th}$) to one fifteenth ($1/15^{th}$).
86. A hollow muscular organ about the size of a man's fist.
87. In the lower left section of the chest cavity.
88. To keep the blood in constant circulation by its pump-like action.
89. About seventy two (72) times per minute.
90. The arteries, veins, and capillaries.
91. To carry pure blood from the heart.
92. To return impure blood to the heart.
93. At the wrist or temple.
94. The flow of blood from an artery, vein or capillary.
95. Bright red blood spurting in jerks from a wound.
96. Dark red blood flowing in a steady stream.
97. Blood oozing from the wound.
98. Bleeding, if unchecked for a short time, may cause death. Loss of blood also complicates the condition of shock.
99. By clotting on exposure to air.
100. Persons whose blood will not clot.
101. (1) Digital pressure (or placing the finger or fingers) on pressure points.

(2) Tourniquet applied on pressure points.
(3) Direct pressure by means of a sterile bandage compress applied to the wound.
(4) Elevation of the injured portion.
(5) Cold application.

102. Apply a sterile bandage compress directly over the wound.
103. By direct pressure over the wound or by compression on the side away from the heart.
104. By digital pressure and application of tourniquet.
105. To check the bleeding immediately.
106. Over a pressure point between the wound and the heart.
107. Places where pressure can be applied to the large arteries.
108. Eleven (11) on each side – twenty-two (22) in all.
109. An appliance used at a pressure point to check severe bleeding.
110. To leave it accessible to be loosened and tightened.
111. Not more than ten (10) minutes.
112. The part of the body away from the heart may die from lack of blood.
113. On the skull immediately in front of the upper part of the ear and in the neck one (1) inch to the side of the Adam's apple.
114. On the lower jawbone near the angle of the jaw.
115. Deep down and back over the center of collarbone on first rib.
116. In the armpit.
117. In the inner side of the big muscle of the upper arm and at the center of the bend of the elbow.
118. On each side of front of wrist.
119. In the groin.
120. In the groin or on the inner side of the thigh about three (3) inches below the crotch.
121. About the center of the bend of the knee.
122. A belt or a cravat bandage.
123. Faintness, cold skin, pale face, dilated pupils, thirst, feeble and irregular breathing, sighing, clouded vision, weakness, rapid pulse, dizziness, and later, loss of consciousness.
124. Keep head lower than body, apply cold applications to body where bleeding appears to be.
125. Not unless absolutely necessary. Ice water may be given slowly.

ANSWER SHEET FOR PHYSICAL SHOCK

126. The treatment for physical shock.
127. To keep the different parts of the body in touch with each other and to control and regulate the functions of the organs.
128. A series of nerve centers called ganglions located in the chest and abdominal cavities along the spinal column.
129. It controls the involuntary action of the vital organs.
130. A state of prostration of the nervous system which interferes with the action of the vital organs.
131. Exposure to injury, loss of blood, exposure to heat or cold, and sights of violence or emotional disturbance.
132. The effects of physical shock are often serious and may be fatal.
133. Immediately after bleeding is controlled.
134. Until the patient receives medical attention.

135. Face is pale and skin covered with cold clammy sweat.
136. The eyelids droop eyes are dull and pupils large.
137. Shallow and may be irregular.
138. Rapid and weak.
139. Somewhat stupid and indifferent may be partially or totally unconscious.
140. The patient may suffer from nausea and vomiting.
141. Keep head low, keep warm and comfortable, give stimulants, remove foreign bodies from patients mouth, see that tongue is forward, and loosen tight clothing from neck, chest, and waist.
142. When there is a fractured skull or severe hemorrhage from the head.
143. When the person has a fractured skull severe bleeding from the head internal bleeding or arterial bleeding (until controlled).
144. Heat pads, hot water bottles, hot bricks, stones, etc.
145. Wrap heat applications in cloth or paper and test before applying.
146. Aromatic spirits of ammonia hot coffee, hot tea or hot water.
147. A teaspoonful in a half-glass of water.
148. Raise person's head and allow him to take liquid in sips from a glass.
149. When the patient is conscious and severe bleeding has been checked.
150. By permitting patient to inhale the fumes or aromatic spirits of ammonia.
151. In a condition of sunstroke.
152. Prolonged exposure to the sun or high temperatures.
153. (1) Unconsciousness.
    (2) The face is red and flushed.
    (3) The skin is hot and dry.
    (4) No perspiration.
    (5) Breathing is labored and snoring.
    (6) The pupils are enlarged.
    (7) The pulse is slow and full.
154. Reduce the body temperature with cold applications, elevate head and shoulders, rub extremities toward the heart, give no stimulants.
155. A hemorrhage in the brain.
156. (1) Unconsciousness.
    (2) Face flushed and warm.
    (3) Pulse at first slow and strong later rapid and weak.
    (4) Respiration slow with cheeks puffing out at each expiration.
    (5) Pupils unequal in size.
    (6) Usually paralysis on one side of body

157. Elevate head and shoulders, keep the body warm, apply cold cloths to head.
158. None.
159. Temporary unconsciousness due to lack of blood supply to the brain.
160. The patient feels weak and becomes dizzy, black spots spear before his eyes, his face is pale, lips blue, forehead covered with perspiration, pulse weak and rapid, respiration shallow.
161. Keep head low, administer fumes of aromatic spirits of ammonia.
162. Collapse from the effects of heat.
163. Physical shock.
164. Physical shock.
165. Shock fainting, heat exhaustion and drowning.

166. For fracture or severe bleeding from the head, apoplexy and sunstroke.
167. Painful spasms of the muscles in the abdomen or limbs after exposure to high temperatures.
168. By drinking plenty of water with a good size pinch of salt in each glass.

WOUNDS AND BURNS

169. The care of open wounds and burns.
170. break in the skin.
171. Abrasions, incised, lacerated and punctured.
172. A wound caused by rubbing or scrapping.
173. One in which the edges are smoothly divided by a sharp cutting edge.
174. One in which the edges are ragged.
175. One produced by a pointed instrument.
176. Check hemorrhage and cover with sterile dressings.
177. To avoid infections.
178. By wiping away from the wound with sterile gauze.
179. The doctor.
180. Check the flow of blood by digital pressure and apply tourniquet.
181. Cover completely with sterile compress or sterile gauze and the outer dressing.
182. Over the compress unless conditions do not permit.
183. In compound fractures, in wounds of the eye, and in fractures of the skull.
184. A burn is an injury caused by heat, friction, or chemicals.
185. A burn with moist heat.
186. Use a dressing to exclude the air and prevent infection.
187. Cut around clothing which adheres to skin.
188. Picric acid gauze.
189. Grease and oil must be removed with solvents before medical treatment can be started.
190. A sterile gauze treated with five (0.5) tenths to one (1) percent picric acid solution.
191. Keep burned surfaces from touching. Be aseptic.
192. Loosely.
193. Wash with large quantities of clean water.
194. Wash thoroughly with clean water.
195. The compress, the triangular, and cravat bandages.
196. Firmly, but never tightly.
197. Place base of triangular bandage over shoulder on injured side with apex toward elbows. Place injured arm across chest. Carry lower end of bandage over shoulder on uninjured side and tie in back of neck. Tuck in apex.
198. Square or reef knot.
199. Injuries to the tissues under the skin.
200. Immediate pain and swelling with discoloration.
201. Apply a cold application.
202. A blood clot may enter and obstruct the blood stream.
203. Overstretching of a muscle or tendon.
204. Rub gently with alcohol or witch hazel and apply heat.
205. Stretching or tearing of ligaments about a joint.
206. Treat as a fracture.

207. A protrusion of an internal organ through the wall of the abdomen.
208. A sharp, stinging pain with a swelling at the part affected. Nausea may occur.
209. Place patient on his back with knees elevated. Apply cold applications.
210. Dislodge with sterile gauze, if not imbedded in eyeball.
211. Float out with warm oil or obtain medical assistance.
212. Induce sneezing or obtain medical assistance.
213. Produce coughing or stand on head and slap on back.
214. Obtain medical assistance.
215. Elevate limb and apply dressing as for wound.
216. Rip at seam or cut away.

ANSWER SHEET FOR DISLOCATIONS AND FRACTURES

217. The care of dislocations and fractures.
218. The slipping out of normal position of one or more bones forming a joint.
219. The ligaments are stretched and sometimes torn.
220. Rigidity, deformity, pain and swelling.
221. Apply dressings or splints in line of deformity.
222. Dislocations of the fingers, toes and lower jaw.
223. With the back of the hand upward grasp, the dislocated joint on each side and pull straight out.
224. Protect thumbs with padding, place will back on lower teeth and with fingers on outside of lower jaw, press downward and then backward.
225. Bind arm to body with large pad under arm and apply triangular bandage sling.
226. With a splint from one (1) inch below the armpit to one (1) inch beyond end of middle finger.
227. With an L-shaped splint from one (1) inch below the armpit to one(1) inch beyond the end of the middle finger.
228. With broken-back splint or wide board.
229. With a splint extending from the top of the shoulder to three (3) inches beyond the heel.
230. Two (2) splints seven (7) feet long, and one (1) inch thick, and six (6) inches wide connected about two (2) inches apart by three (3) splints twenty two (22) long, four (4) inches wide, and one and one half (1 1/2) inches thick, at the shoulders, hips and ankles.
231. A broken bone.
232. Simple and compound fractures.
233. A broken bone with no open wound.
234. A broken bone with communicating open wound.
235. It may be converted into a compound fracture.
236. Rough handling may force the broken bone through the skin.
237.

(1) Pain and tenderness at the point of fracture.
(2) Inability to move broken limb.
(3) A grating when the limb is handled.
(4) Shortening or deformity of the limb.

238. Do not change position until after a careful examination of the fracture.
239. Keep in as neutral a position as possible and pull limb gently and steadily.

240. Sterile bandage compress and cravat or triangular bandage.
241. Treatment for shock.
242. Blood and serum may flow from the ears, bleeding may be seen in the eyes, ears, nose, and mouth and the pupils may be unequal in size.
243. The patient may be conscious or unconscious.
244. Elevate head on soft material, turn head so it rests away from location of fracture, treat for shock but give no stimulant.
245. Dress wound with a compress and cover with a dravat bandage with the knots tied away from the wound.
246. The mouth is usually open with the teeth uneven at the break.
247. The arm is partially helpless, the shoulder is lower and droops forward.
248. Bind arm firmly to the body with large pad under arm pit and apply triangular sling.
249. Place forearm in triangular sling and bind arm securely to the body.
250. Bind the arm firmly to the body, place forearm in triangular sling.
251. With an L-shaped splint from one (1) inch below the armpit to one (1) inch beyond the end of the middle finger.
252. With an L-shaped splint from one (1) inch below the armpit to one (1) inch beyond the end of the middle finger.
253. With an L-shaped splint from one (1) inch below the armpit to one (1) inch beyond the end of the middle finger.
254. With an L-shaped splint from one (1) inch below the armpit to one (1) inch beyond the end of the middle finger.
255. With a splint on the inside of the arm from the elbow to one (1) inch beyond the end of the middle finger.
256. Severe pain in breathing tenderness at fracture.
257. Tie three (3) wide cravat bandages tightly around body.
258. The spinal cord may be cut or pinched.
259. The patient is unable to move legs. If unable also to move arms, the fracture is higher up.
260. Do not try to straighten. Treat for shock and send for the doctor.
261. With a broken-back splint.
262. Fifteen (15).
263. Thirteen (13).
264. With face down.
265. Severe pain through the pelvis and inability to move either or both thighs.
266. A punctured bladder.
267. By supporting the pelvis from movement with wide tight bandages and by keeping the patient flat on his back.
268. Secure on broken-back splint with eight (8) bandages or on wide board with five (5) bandages.
269. Apply tourniquet and cover with compress bandage. Apply splint from top of shoulder to three (3) inches beyond heel.
270. With a splint extending from top of shoulder to three (3) inches beyond.
271. With a splint extending from top of shoulder to three (3) inches beyond.
272. With a splint on bottom of foot extending one-half (1/2) inch beyond toes and heel.

ANSWER SHEET FOR
TRANSPORTATION OF THE INJURED

273. The transportation of the injured.
274. The emergency car of an injured person before medical assistance is secured.
275. Make the injured person comfortable and render first aid.
276. To assure proper care of those injured or sick and to make all employees more safety minded.
277. To keep them thoroughly acquainted with the fundamentals of first aid.
278. Make a thorough examination and protect injuries by proper dressings.
279. In a reclining position.
280. Test the stretcher for strength.
281. On uninjured or least injured side.
282. Rear men breaks up.

ANSWER SHEET FOR
FIRST AID

1.	c	6	d
2.	d	7.	c
3.	c	8.	b
4.	c	9	a
5.	a	10.	a

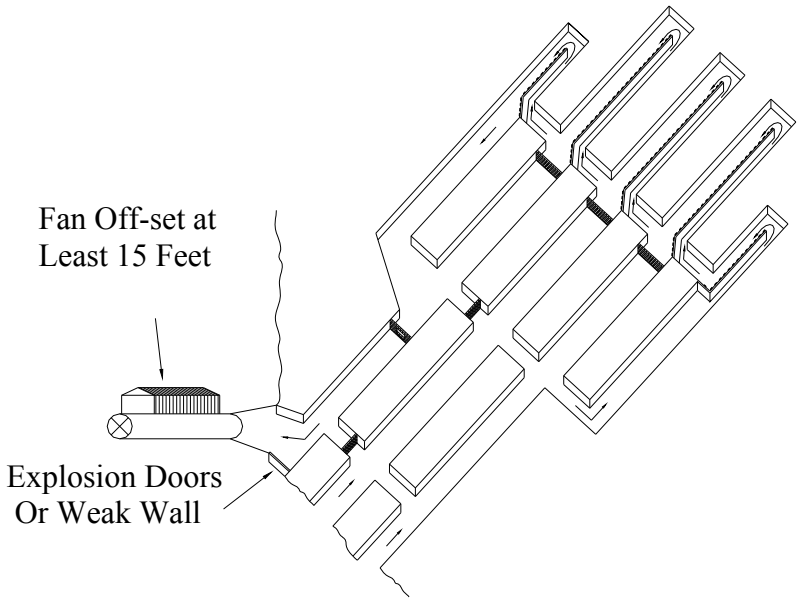
CHAPTER ELEVEN

MAP GUIDE

1. Instruction for Ventilating Mine Maps
2. Mine Fan
3. Permanent Stopping
4. Overcasts
5. Check Curtain and Line Brattice
6. Regulators
7. Box Checks
8. Instructions for Removing Gas and Sealing Mine Fire

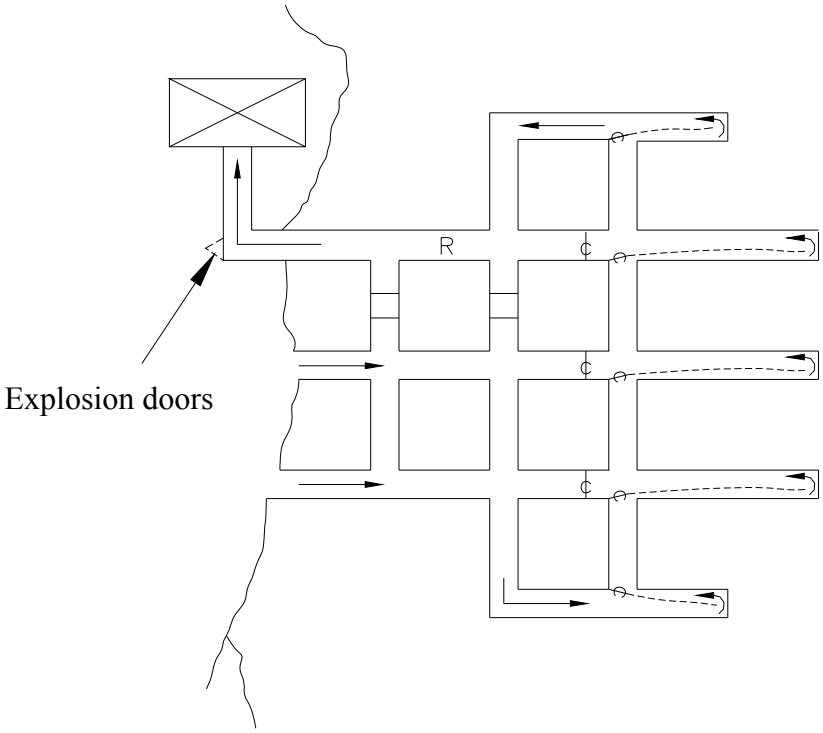
INSTRUCTIONS FOR VENTILATING MAPS

1. Neatness is the first rule for ventilating maps. Arrows and ventilating controls should be as neat and workmanlike as it is practical to make them.
2. All ventilating controls and arrows showing direction of air flow are to be drawn with a black lead pencil.
3. All arrows are to be drawn with a ruler as guide. ⟶
4. Air currents should be so well outlined that it will be easy to trace them at a glance.
5. Show all places where the air splits by this symbol. ⟶
6. Study the map and get a general idea of how the air should be coursed, taking haulage into consideration as well as the probable types of equipment used.
7. Whenever possible, separate main intake and return air with long chain pillars.
8. After deciding on the flow of air, ventilate the main entries. This establishes the main intakes and returns.
9. Now set the fan, offsetting it 15' from the opening and indicating the explosion doors. Beside the fan write the following mine law pertaining to the fan.
    1) Offset at least 15' feet.
    2) Fireproof air ducts provided with explosion doors or weak wall.
    3) Operated from independent power circuit
    4) Provided with pressure recording gauges or water gauges.
    5) Daily inspection of fan and a record of inspection kept in a book or by facilities to permanently record or give warning of an interruption to the fan.
10. Next, ventilate one butt entry taking into consideration the haulage and the manner in which the air will be coursed into and out of each individual section.
11. Ventilate one section at a time on the butt entry and place each section on a separate split of air. In general, ventilate the least developed section first.
12. When ventilating the sections first indicate by arrows where you want the air to go. Then place the necessary controls to make it go that way. For example: Show the flow of air by arrows. Then place the permanent stoppings and doors. Next place temporary stoppings and checks. Then if you are air locking a section, check to see if you do have an airlock. Now put line brattice or ventilating tubing in all places that are in more than 2 cuts or 20 feet. Last, regulate all splits of air. For example, you may have air going out the main return to regulate and a bleeder for a pillar line to regulate.
13. When ventilating a section that has both solid and pillared workings, course the air over the solid workings first. Air used for ventilating abandoned or pillared workings should be coursed directly to the return.
14. Air locks are placed where there is danger of interruption to face ventilation. In general, sections such as those that use track mounted face equipment or pan lines to the faces or hand loading into cars or conveyors should be air locked.
15. Where possible, sections that use shuttle cars should be ventilated by taking the air up the middle headings and splitting the air at the face (fish-tailing). This will reduce the problem of removing gas and sealing in the event of a mine fire.
16. Every split of air should be regulated. Regulators should be placed so that one regulator does not regulate another (double regulation).
17. Mark all violations of the mine law.
18. Check maps carefully. Be sure that all controls are in and properly placed. Check the air flow to be certain there are no short circuits and that one regulator is not regulating another.



Air circulates through a mine because there is a difference in pressure between the intake and the return. The difference in pressure can be created by the difference in temperature, elevation, or by mechanical means. See illustrations. Natural ventilation isn't reliable because the direction, of the air current, may reverse with weather conditions, and when the outside temperature approximates the inside temperature, movement of air will cease.

The most reliable method of producing ventilation (coursing of air through a mine) is by a fan operated mechanically. A mine fan must be located on the surface, and must be built with incombustible material, equipped with fire proof air ducts and provided with explosion doors or a weak wall.



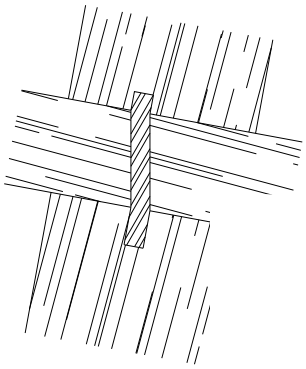


Figure 1

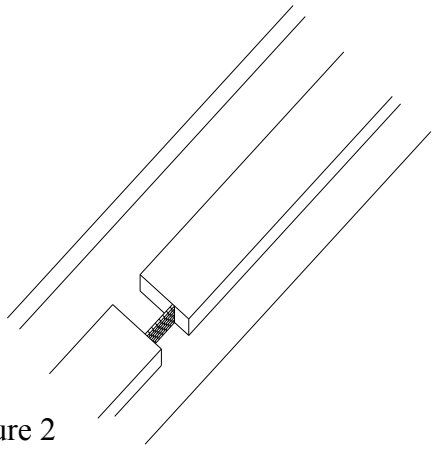


Figure 2

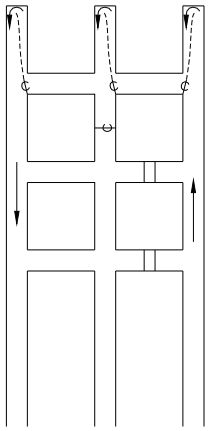


Figure 3

PERMANENT STOPPING

The purpose of a stopping is to prevent the short circuiting of the air or to seal off portions of the mine. Short circuiting of air is permitting it to enter the return before it has reached the working faces.

A leaky stopping will increase the cost of ventilation. The fan will be required to move a greater quantity of air than necessary to properly ventilate the working areas. Therefore, a stopping should be airtight and substantial. One common area of leakage in the construction of a stopping is around the sides and on the bottom. When possible a stopping should be embedded into the rib and bottom. See illustration #1.

OVERCAST

An overcast is a bridge which allows one air current to pass over another air current. Usually overcasts are built in an intersection opposite a break-through. See Figure #1 and #2. an air bridge is an aid to ventilation because it permits frequent splitting of the air - allowing air to pass only over one section or one portion of a mine. An overcast also aids the haulage of a mine because it eliminates the necessity for doors on the haulage road. The most common errors made in the construction of a overcast are: rough and abrupt interruption to the ventilating current, and insufficient area. The area on the inside of the overcast which butts up against the construction should be filled in with material and smoothed down so that air will flow easily over the top of the overcast. The distance from the top of the overcast to the roof should be of sufficient area to allow air to pass freely. See Figure #3.

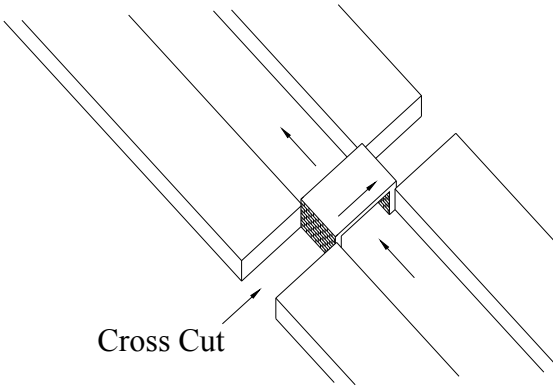


Figure #1

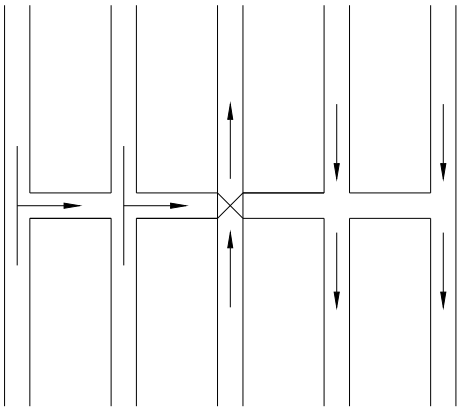
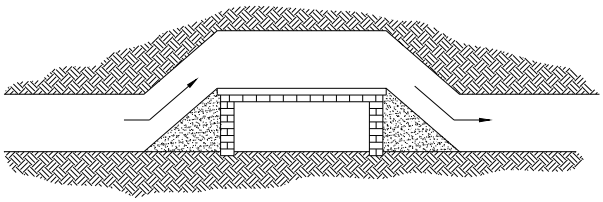
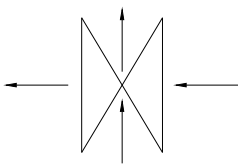


Figure #2

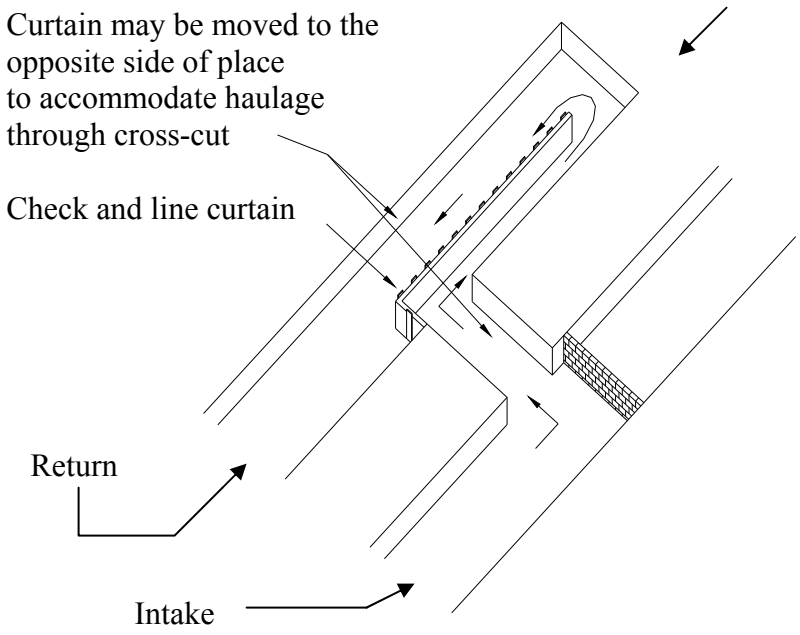
Figure #3

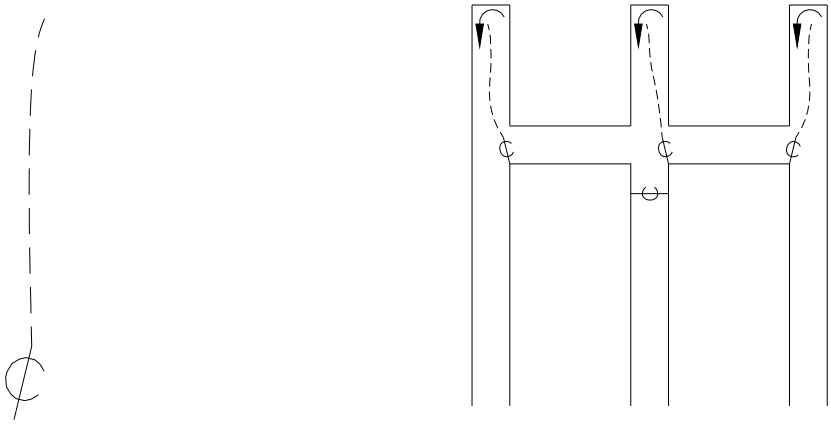




CHECK CURTAIN AND LINE BRATTICE

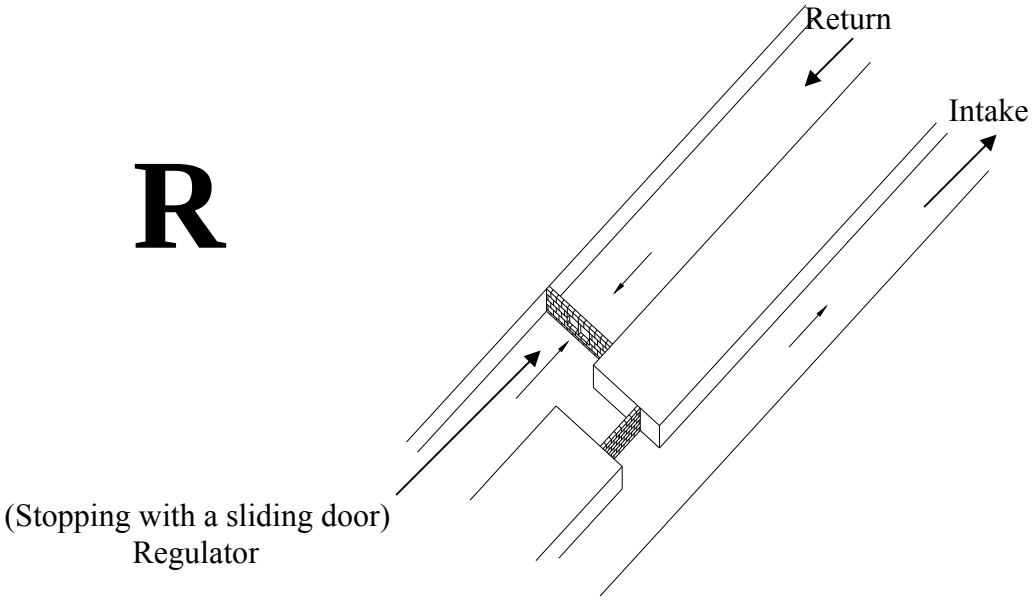
The purpose of a check curtain is to deflect an air current from an entry into a working face and should only be used in the active working area. The use of a line brattice with a check curtain is a standard practice in coal mining. See examples. The material used is brattice cloth or incombustible material and must be flame resistant. The purpose of a line brattice is to assure a sufficient velocity of air at the working face to remove dangerous gases, smoke from explosives, and to carry away harmful coal dust. The most common error in the use of line curtain is the choking of the air in behind the curtain. Therefore, the space behind a line curtain should be clear and open for the free flow of air. At times a greater velocity of air may be needed at the face area to remove gas.
In such cases the intake current can be constricted, thereby creating a greater velocity and the gas is removed.

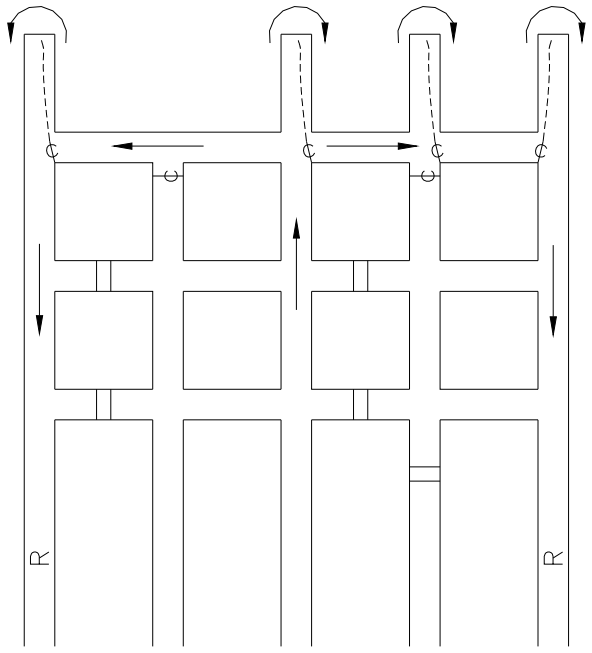




REGULATOR

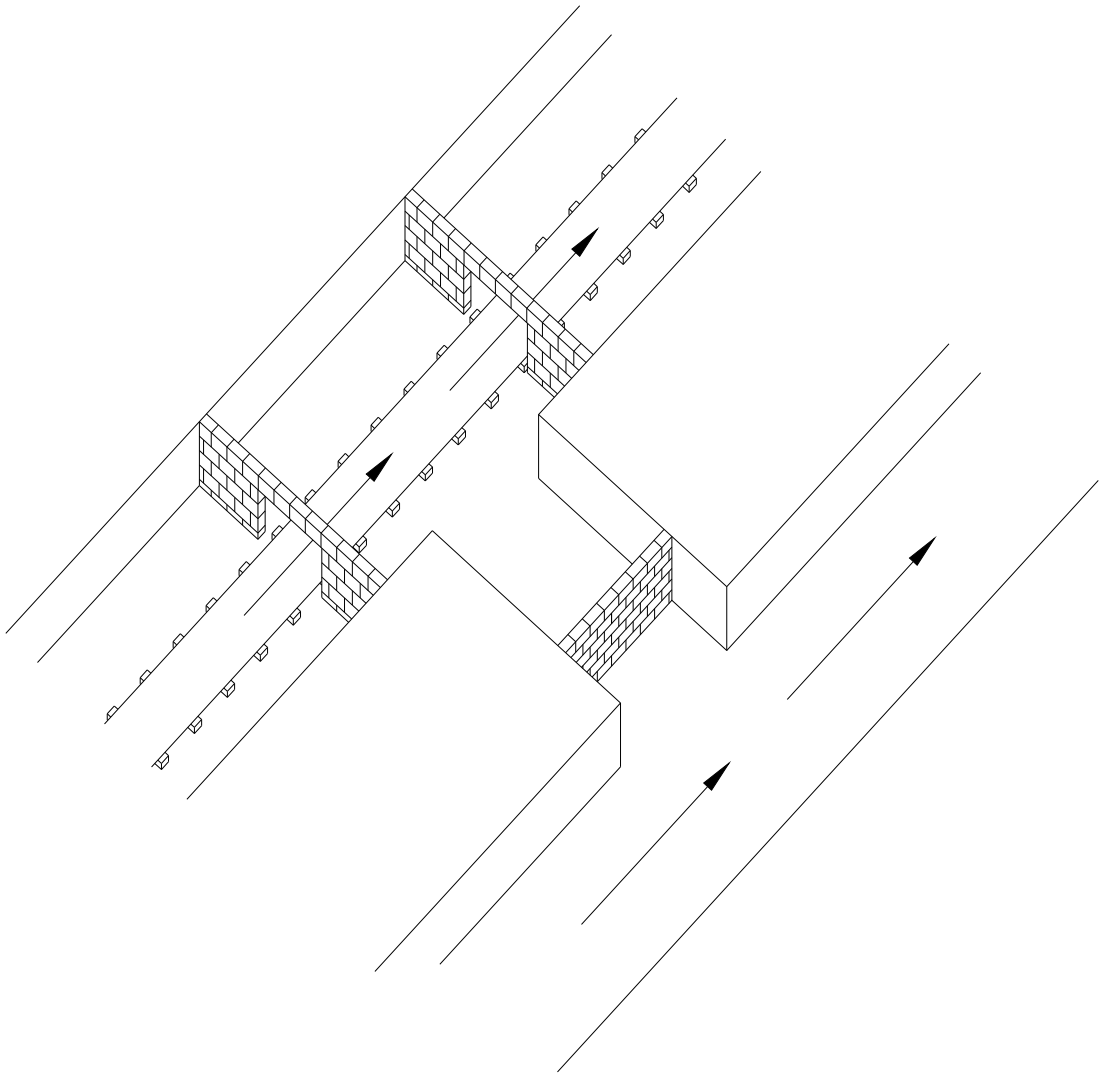
The purpose of a regulator is to control the distribution of air by regulating the resistance to flow in an air split. Therefore, the effect of closing a regulator on the quantity of air is that the quantity will decrease. Regulators are essential to the ventilation of a mine because they proportion the air to meet the requirements of each individual split. Regulators are placed in the return of each split of air. The mine foreman—who is charged with the responsibility of ventilating coal mines in Utah—will determine where regulators are to be placed. The materials used in the construction of a regulator should be incombustible.

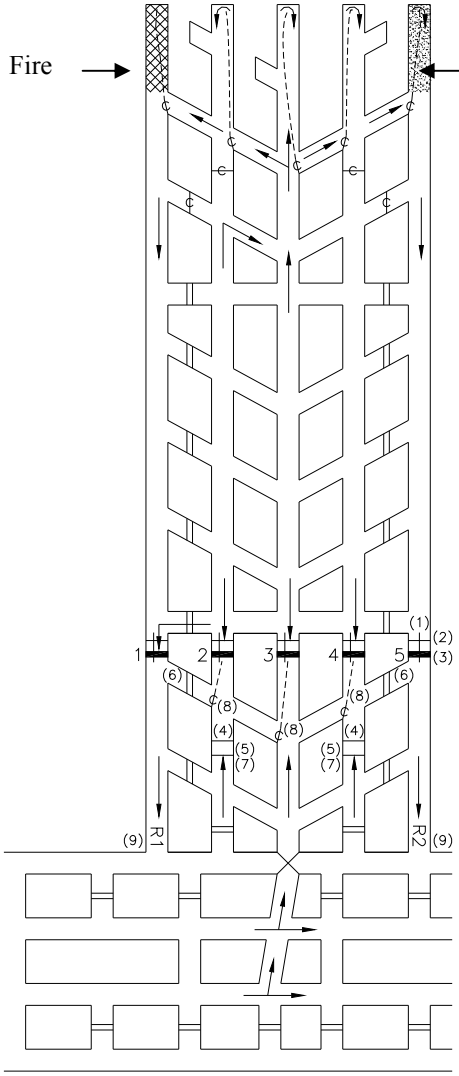




BOX---CHECK

Where belts or panlines pass through a stopping they should be boxed checked to prevent excess leakage of air. Notice in the example below a belt line is passing through two permanent stoppings. The belt is ventilated by the leakage of air through the stoppings.





1. Pull power
2. Remove men except those necessary to remove gas and seal fire.
3. To get more air to remove gas; tighten check and line curtain open regulator No. 2.
4. Approximately 1000 feet from fire area build temporary seals.
5. Build permanent seals. Build seals No. 2 and No. 4 first, then build seals No. 1, No. 3, and No. 5 simultaneously. Seals No.1, No. 3, and No.5 must be raised together to prevent the possibility of reversing the air in the fire area.. If necessary put in water traps. Make as airtight as possible.
6. Establish ventilation across seals by removing stoppings 6, build stopping 7, and run line curtain to face 8. Adjust regulators No. 1 and No. 2.

(1) Sample Tubes
(2) Temporary Seals
(3) Permanent Seals
(4) Temporary Stoppings
(5) Permanent Stoppings
(6) Remove Stoppings
(7) Build Stoppings

(8) Run Line Curtain to Stoppings

(9) Adjust Regulators

Instructions for Removing Gas and Sealing Mine Fire

1. Pull power
2. Remove men except those necessary to remove the gas and seal the fire.
3. Route the gas away from the fire area so the gas does not cross the fire and cause an explosion.
4. Increase the volume of air to remove the gas
5. Approximately 1,000 feet from the fire area build temporary seals approximately straight across.
6. Outby the temporary seals build permanent seals. When building seals the last seals to be built are one in each return and one in the intake. These are raised together so as to prevent the possibility of reversing the air in the fire area. Sample tubes are put in two or more seals. This sampling is done about 72 hours after the initial sealing for the purpose of determining whether the oxygen content is low enough so there is no danger of an explosion. If necessary put water traps in the seals.
7. Ventilate the seals

CHAPTER TWELVE

I. LONGWALL MINING

by Joy Manufacturing Company---by permission of Joy Manufacturing Company

1. Typical Block of Coal to be Mined by Longwall
2. Face Conveyor
3. Shearer
4. Chock
5. Longwall Mine Layout
6. Longwall Cycle
    a. Stage 1
    b. Stage 2
    c. Stage 3
    d. Stage 4
    e. Stage 5

II. AMERICAN LONGWALL PROBLEMS

by Charles T. Holland---by permission of Mining congress Journal

1. Introduction
2. Pillar Lines Have Longwall Characteristics
3. Theory of Stress
4. Fragile Roof
5. System Layouts
6. Solution to Tailgate Problems
7. Longwall Faces
8. Longwall---Block System
9. Recovery
10. Conditions

LONGWALL MINING

The newest mining system in which we are making excellent progress in the U.S. has actually been used for many years in some sections of Europe. This is the longwall system. Because continuous haulage can be rather simply applied to longwall, it approaches true continuous mining. Mining is done across a long face which can be any length from 300 feet to 800 feet. As the mining is done along the face, hydraulic, self-advancing roof supports protect equipment and personnel in the working area. As mining advances, and the supports are moved forward, the roof behind the support caves. This is called the "gob'. The actual mining is done by a shearing machine which pulls itself along the armored face conveyor. Shoes on the shearer ride on rails at the edges of the conveyor. The shearer takes a 24" or 30" cut along the full length of the face, and the loose coal is directed into the conveyor by the spiral configuration of the shearer drums. After the shearer has passed along the face, hydraulic rams on the roof supports, or chock, push the conveyor forward and then pull themselves up into place over it by means of the same hydraulic rams. At the end of a cut across the face, the conveyor, with the shearer in place, is moved forward while the shearing drums sump into the new face. It then begins another cut in the opposite direction, making an almost continuous flow of coal. As the coal comes off the face conveyor, it is conveyed by a stage loader, a chain conveyor which remains attached to the end of the face conveyor. The stage loader dumps onto an extensible belt conveyor which carries the coal to a butt belt for transfer to main haulage.

The face equipment which we now furnish for longwall mining is of European design. The roof supports are designed by Gullick-Dobson, Ltd. in England. These supports have either two, four, five or six hydraulic cylinders, or legs, depending on the amount of weight which must be supported. The cap piece, held in place by the legs is of sufficient length to extend right up to the face which is being mined. The hydraulic ram which pushes the conveyor forward and then pulls the chock forward is at the bottom center of the chock. These self-advancing supports have been the key piece of equipment in mechanizing the longwall mining system. Without them, the system could not approach competing with conventional or continuous mining. Now, under the right conditions it can compete very well. There are presently about 35 longwall faces in the U.S. and more are being planned.

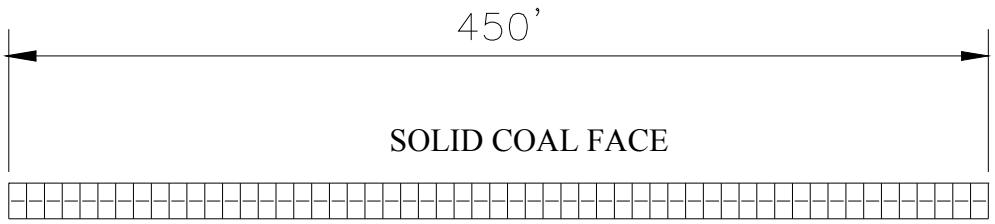
The face conveyor is a sectionalized chain conveyor, heavy enough to support the shearing machine on its side rails. It has an elevated discharge onto the stage loader. The face conveyor is manufactured by Eickhoff in Germany.

The shearing machine is also of German design by Eickhoff. The cutting drums are on arms which permit raising and lowering to meet conditions. Depending on seam height to be cut, the shearer may have either one or two drums. With the single-drum unit, the one drum cuts the full seam height or may make a low pass in one direction and a high pass in the return direction. Drum speed ranges from 53 to 110 RPM, and drum diameters range form 43" to 63".

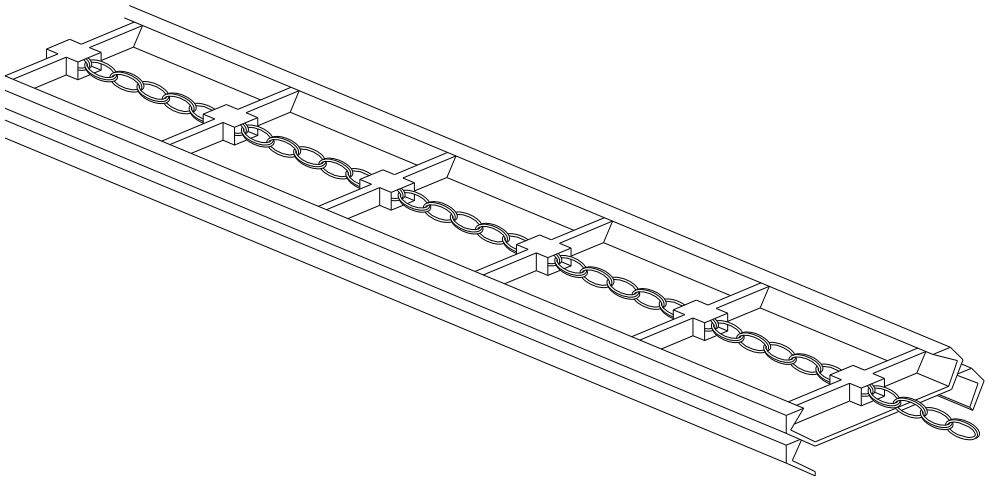
With the double drum shearer, the front drum is lowered to make a bottom cut across the face, and rear drum is raised to cut the remaining coal at the top of the face. It will operate in seam thickness from 43" to 10'.

The conveying equipment beyond the face consists of the Eickhoff stage loader and, in some operations, an extensible belt conveyor.

At the face there is a face conveyor on which the coal is loaded and carried to a belt conveyor. The belt conveyor carries the coal to the dump where the coal is loaded into cars or onto the main haulage belt and then hauled outside.

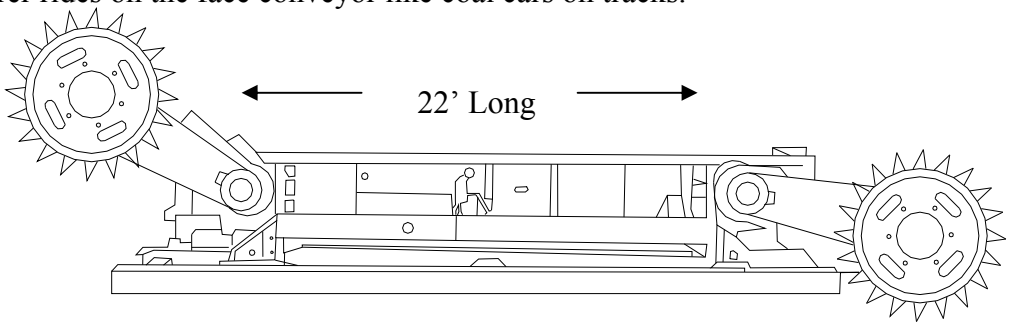


This face conveyor operates much like the conveyors in the loading machines and continuous miners. The face conveyor is in 5' sections so it is flexible. Each section is 5^{o} flexible at each joint.



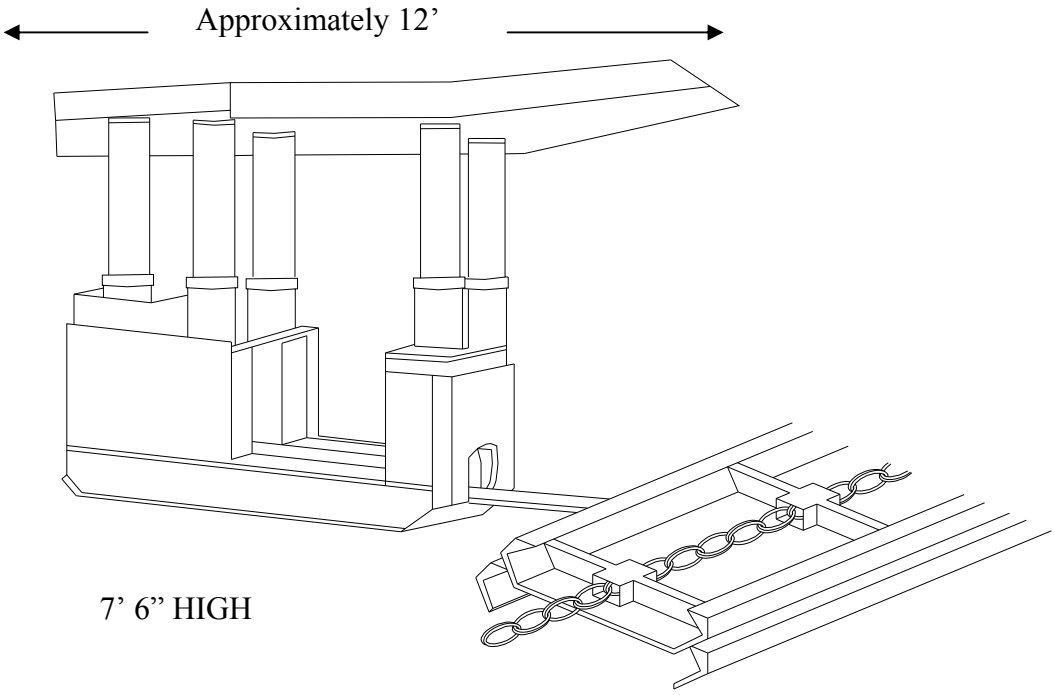
31" wide
8" high
5' sections

The shearer rides on the face conveyor like coal cars on tracks.



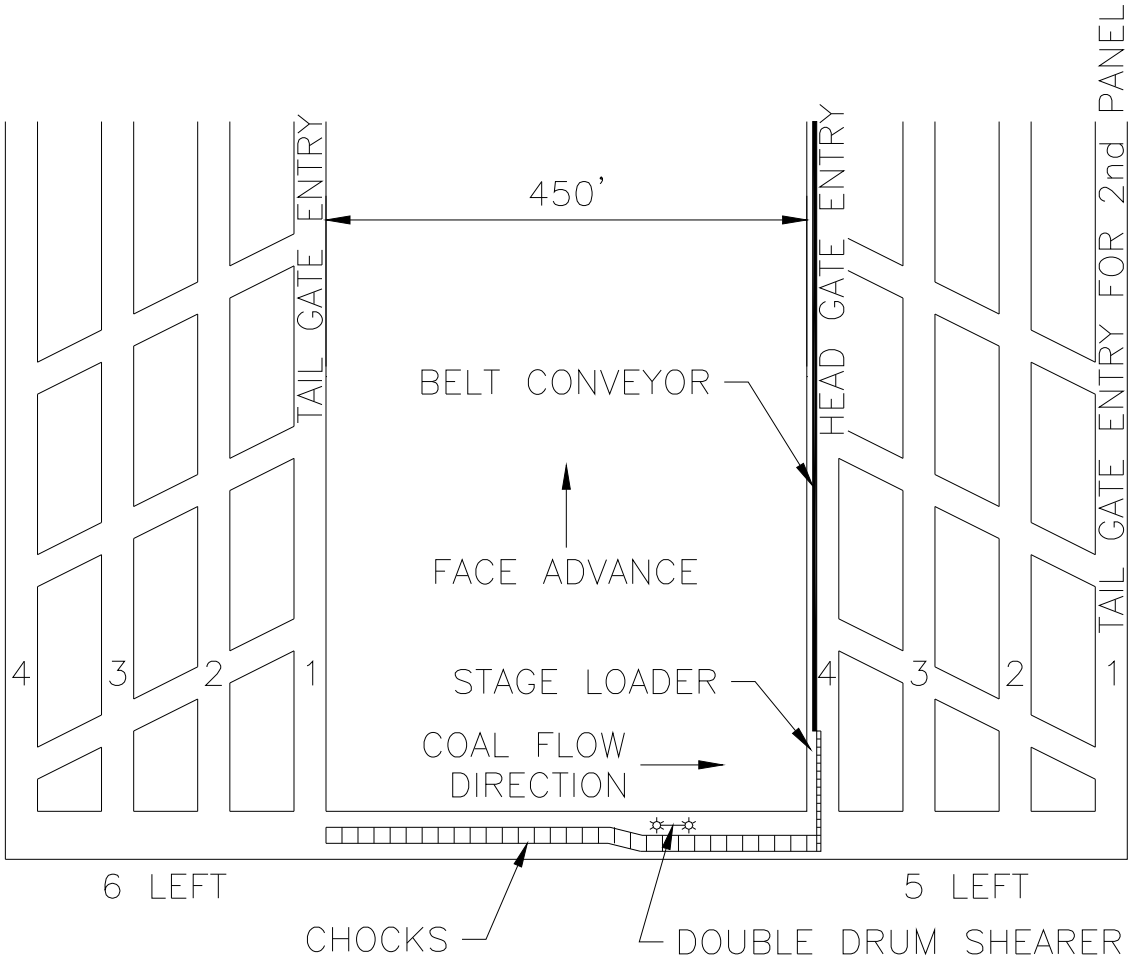
The shearer has two shearing drums which cut the coal. Together the drums can take a 30” cut of coal. One drum cuts the coal at the top of the seam (next to the roof) and the other drum cuts the coal at the bottom of the seam (next to the bottom).

A chock (shield) is a roof support unit and is also used to push the conveyor to the face. Six hydraulic jacks are used for support and one double acting hydraulic cylinder is used to push the conveyor to the face. Each jack will support 85 tons. Each chock will hold 510 tons. The chocks are hooked to the face conveyor by a hydraulic cylinder. When the chock is set (tight against the roof) the face conveyor can be pushed to the coal face by the hydraulic cylinder. The face conveyor is moved to the face after the shearer has passed. Directly behind the chocks the roof caves. The caving behind the chocks is necessary for the longwall to operate properly.



LONGWALL MINE LAYOUT

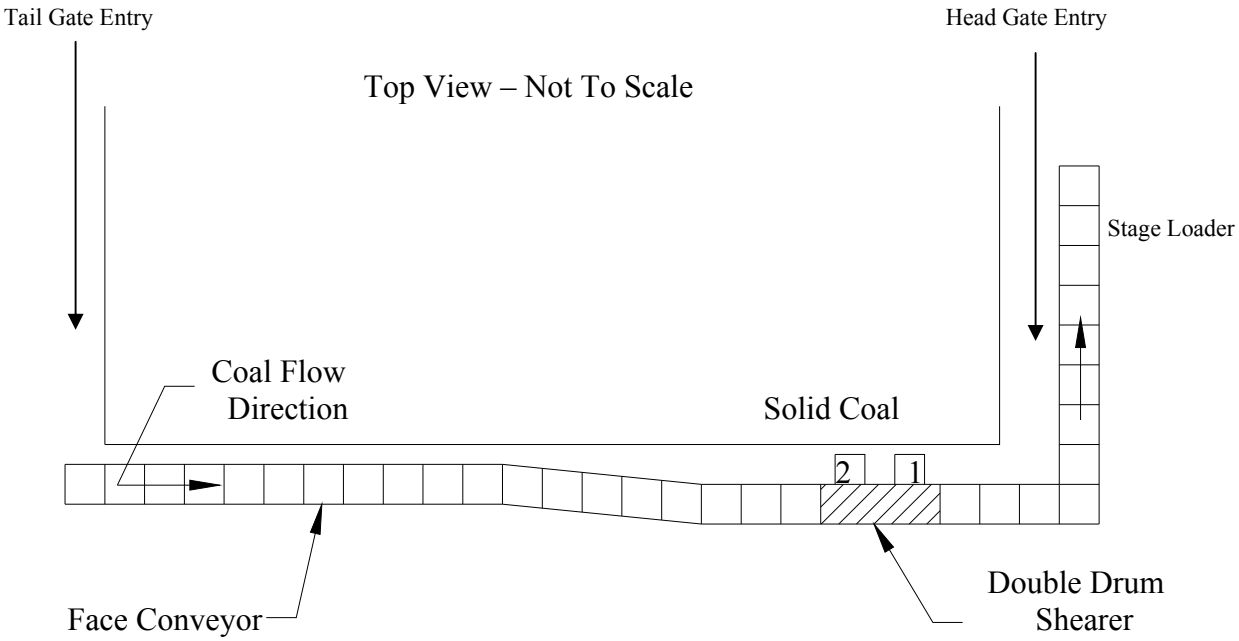
USING A DOUBLE-DRUM SHEARER

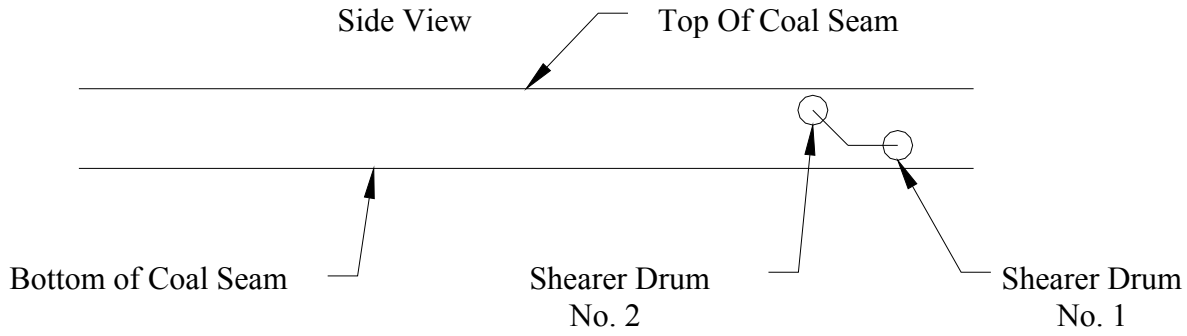


LONGWALL CYCLE

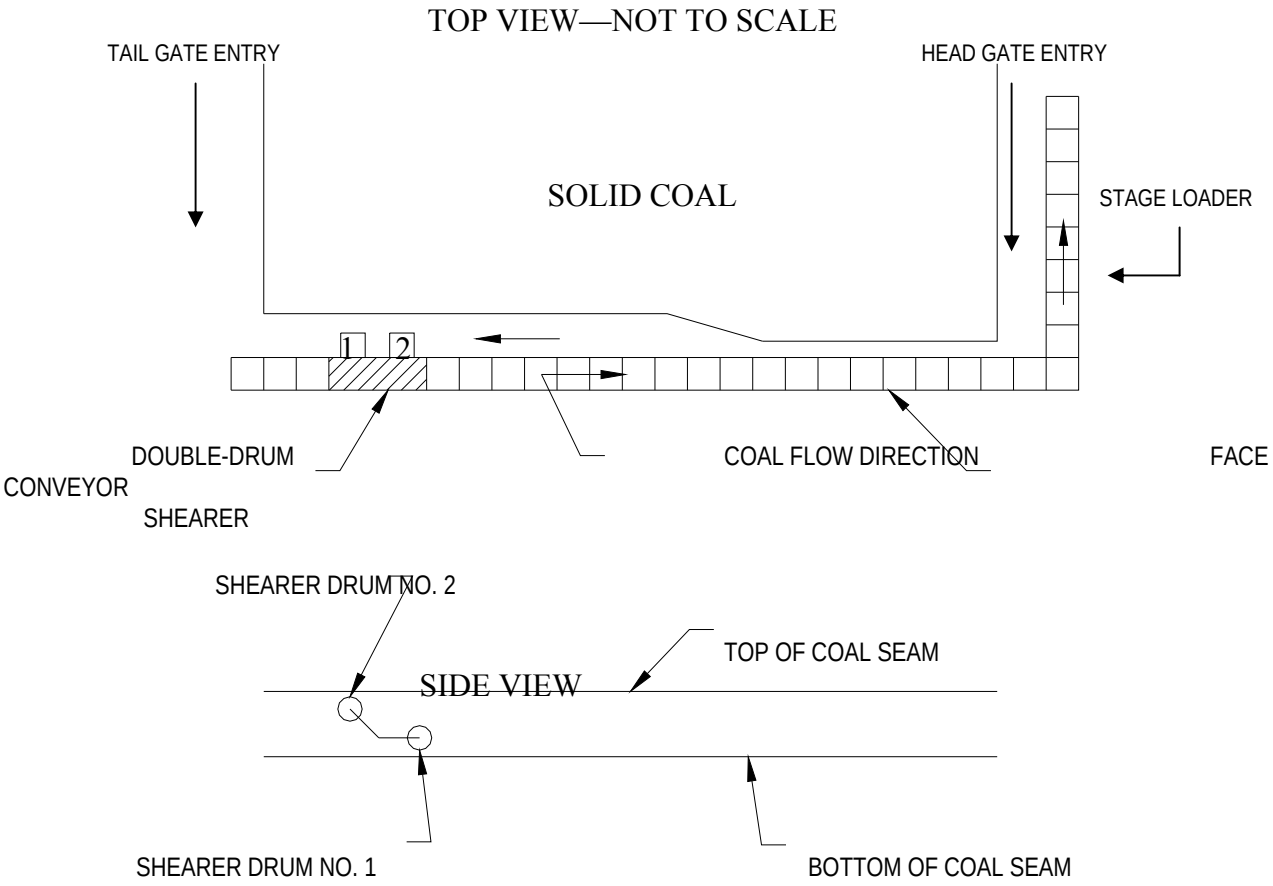
"THE HALF-FACE TECHNIQUE"

STAGE 1: Initially the coal face is straight. Looking directly down on the face equipment— shows the longwall face, straight, with part of the face conveyor at an angle. To save time at the head and tail gate sections, the face conveyor is moved to the face from the tail gate to approximately the middle of the face. This is shown below.



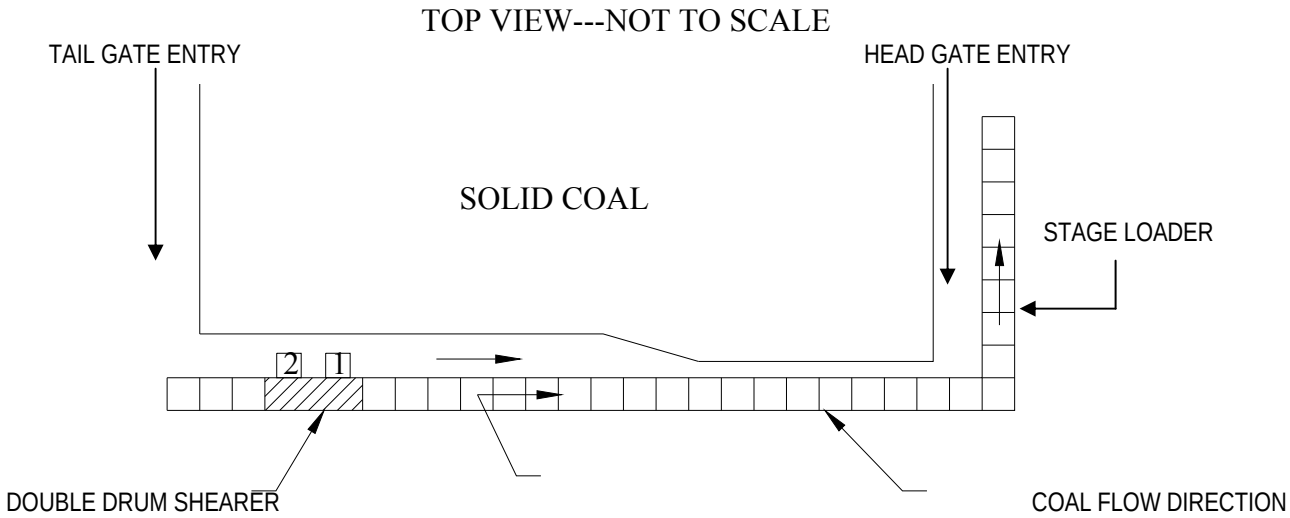


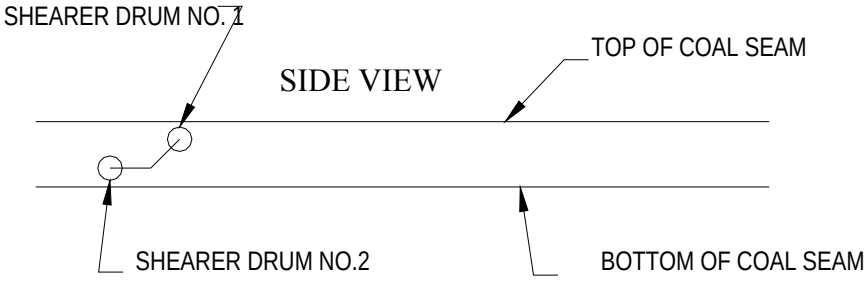
STAGE 2: While the shearer cuts to the tail gate entry, the chocks at the head gate entry will be moved up to the face so the face conveyor is straight as shown below.



STAGE 3: When the shearer reaches the tail gate entry, the No. 2 drum is gradually lowered and cuts to the bottom of the tail gate entry. By lowering the No. 2 drum of the shearer, the face at the tail entry can be completely cut from bottom to top.

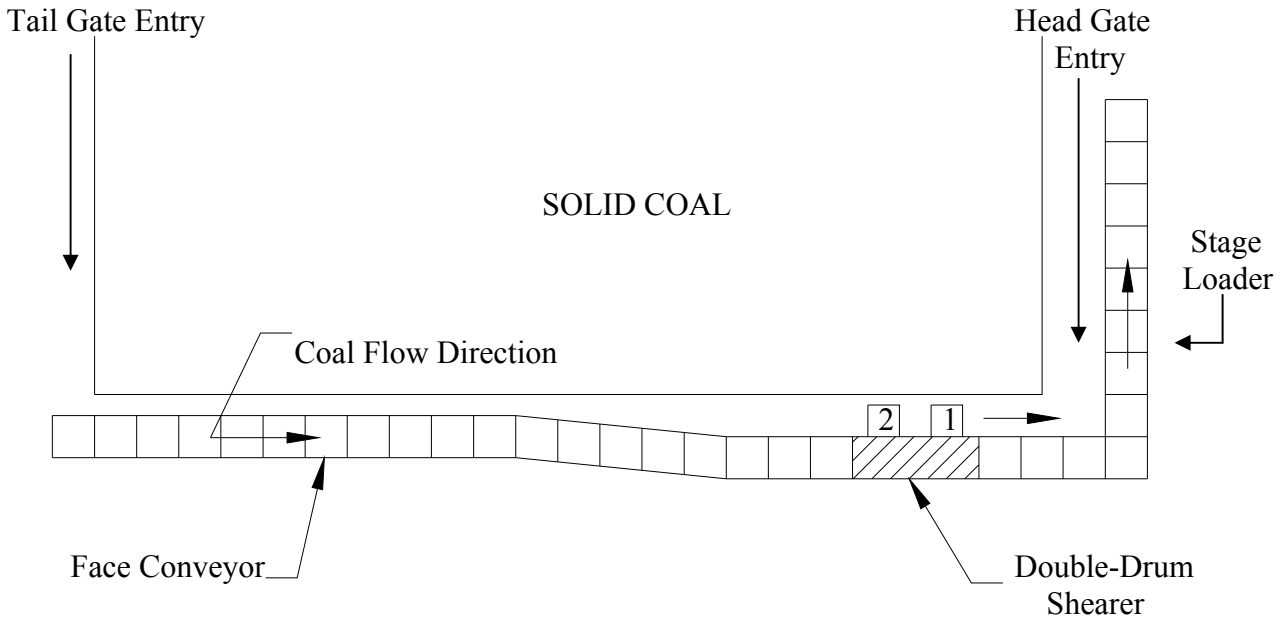
STAGE 4: While the No. 2 drum is completing the cut at the tail entry, the No.1 drum is raised to the top of the coal seam. After the No.2 drum has completed the cut to the tail entry, it is located on the bottom of the coal seam as shown below:



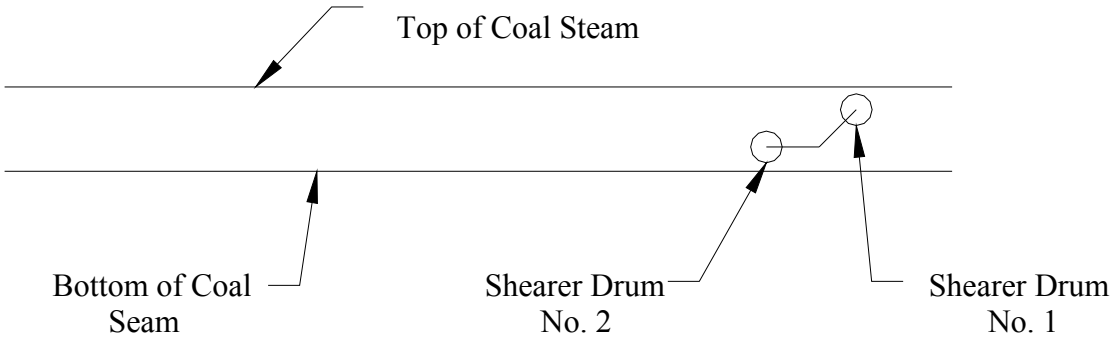


STAGE 5: The shearer is now reversed to cut back to the head gate entry. As soon as the shearer leaves the tail gate, the chocks and face conveyor are pushed forward to the face. Shown below. As the No. 1 drum reaches the head gate entry it will be lowered into the position shown at Stage 1 and then start the cycle over again. The coal face should be straight at the beginning of the cycle (Stage 1) and when it has reached Stage 5. The face conveyor should be straight at Stages 2 and 4.

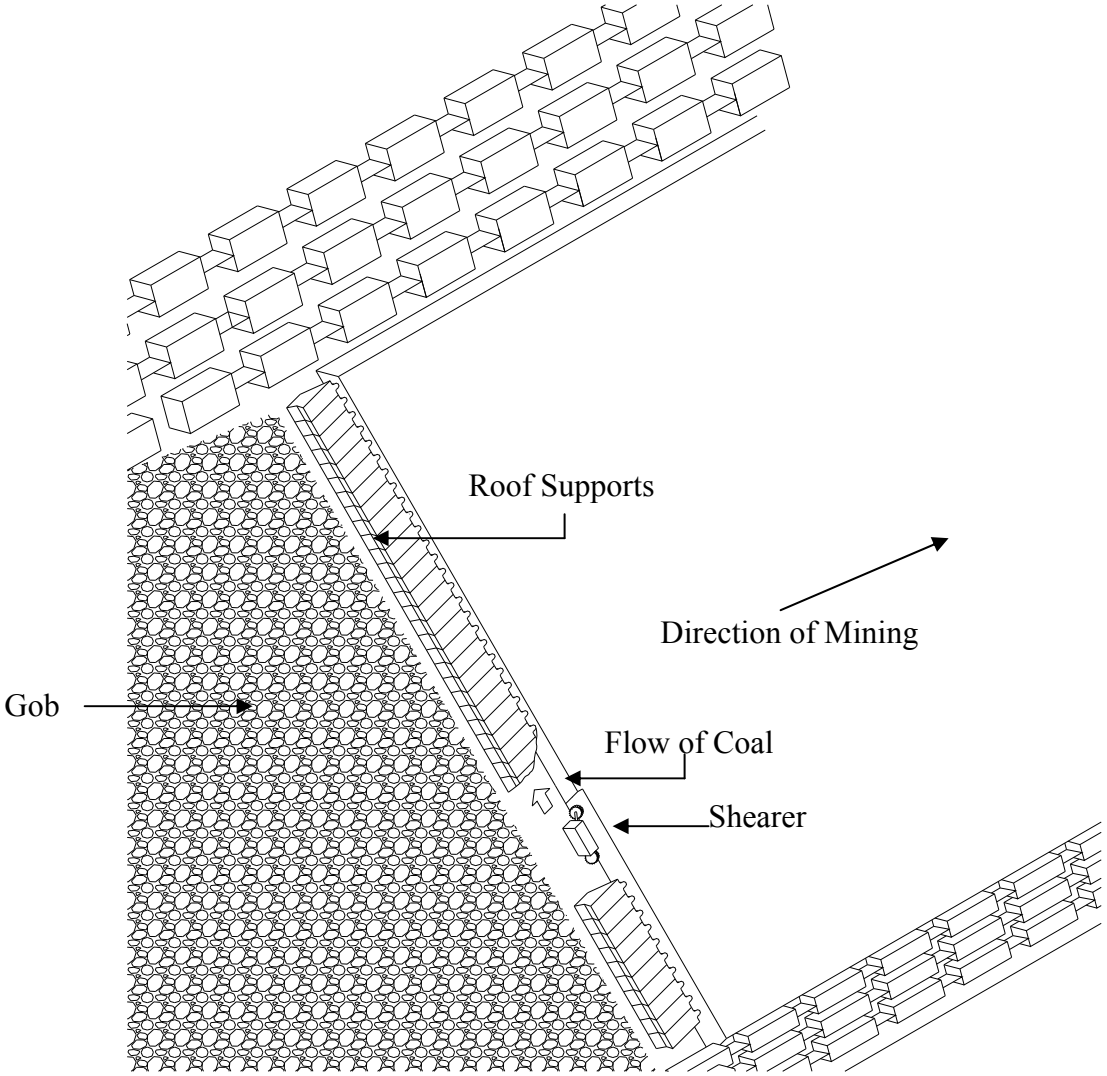
TOP VIEW—NOT TO SCALE



SIDE VIEW



From the face conveyor the stage loader loads the coal onto the conveyor belt which takes it to the mother belt. From the mother belt the coal is loaded into cars or on to the main conveyor and hauled outside.


Roof Supports
Direction of Mining
Gob
Flow of Coal
Shearer

AMERICAN LONGWALL PROBLEMS

Longwall mining involving packwalls, bottom and top ripping has not been practiced in the United States in recent years as it has been elsewhere. Not long ago, however, developments in foreign areas introduced a retreating longwall mining system which makes use of mechanized, self-advancing and power-adjusted roof supports and shearing and plowing coal-getting machines. Offering many advantages, especially in seams less than six feet thick, the system seems to have application in this country.

Where it has been used, it has operated on a competitive basis with the so—called room and pillar system of mining employing either conventional coal cutting and loading equipment or continuous miners. The advantage has been in favor of longwall. Its success has resulted in widespread experimentation on mechanized retreating longwall mining in this country. Signifying the high interest in longwall mining are statements to the effect that U.S. production of coal by this method has doubled every year over the past few years.

In light of the foregoing, the School of Mines at West Virginia University decided to get up-to-date information about results obtained and problems encountered on longwalls. For this purpose, a mining engineer experienced in longwall practice was placed on every coal face being operated at the time—a total of 14—in the U.S. Prominent among the problems found during these visits were those concerned with roof control, gate panel layout, best length of face, moving from one face to another, control of low voltage, selection of face support, ventilation and dust control. Let us focus our attention here on the problems of roof control.

Pillar Lines Have Longwall Characteristics

We in the United States have always claimed to be room and pillar miners, but for years we have in many cases been operating what are essentially retreating and advancing longwall faces in room and pillar mines. Consider, for example, the system shown in Figure 1. This has been used in the Pocahontas coal field of southern West Virginia and it is essentially an advancing longwall extraction system. As development rooms and crosscuts are driven, the pillars are blocked out and these are later extracted as the pillar line advances into the mine. The so-called block system (see Figure 2) has been widely used in northern West Virginia for many years. In this system, pillars to be extracted are developed just ahead of the retreating face, which we call the pillar line. This is in fact a retreating system.

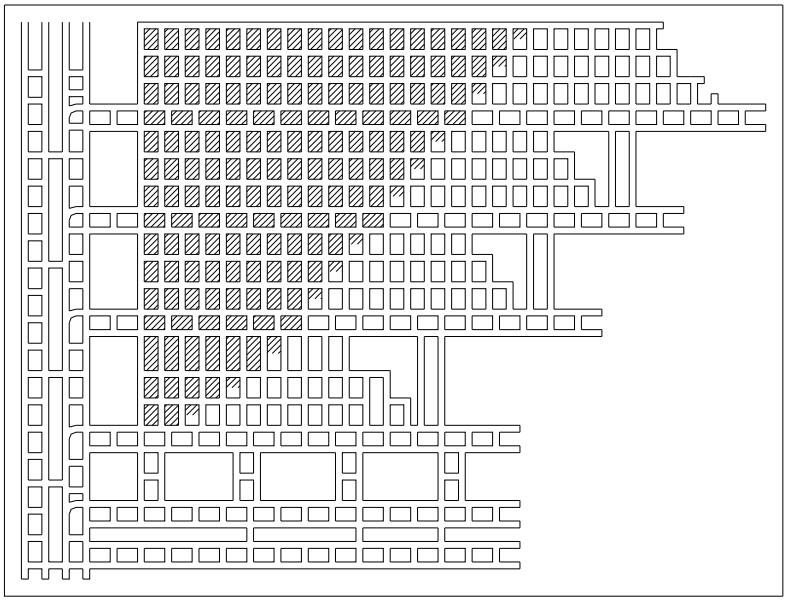


Figure 1. Room and pillar mining plan used in the Pocahontas coal fields. The pillar line, which can advance indefinitely, has many of the attributes of a longwall.

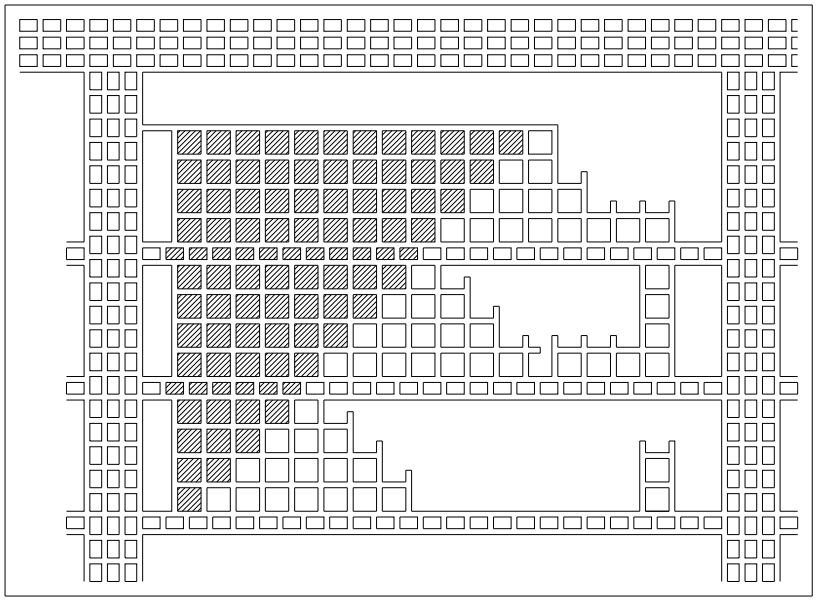


Figure 2. So—called block system has been used in the Fairmont field for many years. The panel system has a definite limit and the pillar line is retreated as the section is developed. The pillar line has many characteristics of a longwall face.

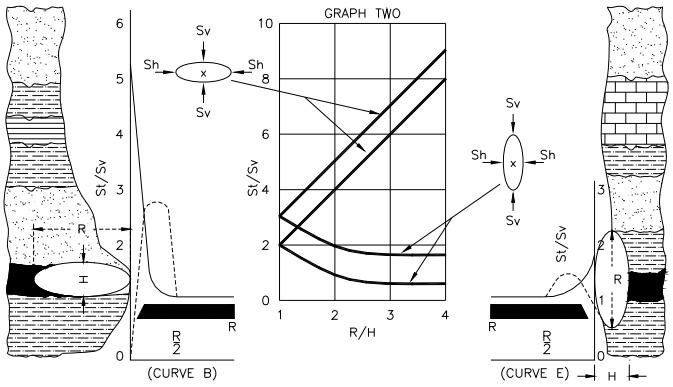


Figure 3. Stresses about mine openings. The shape of opening associated with curve B frequently develops along goaf or pillar lines in strong rock. The opening shape associated with curve E frequently develops in weak rocks.

It will be noted in figures 1 and 2 that the retreating or advancing pillar line, as the case may be, is about 1400 or 1500 feet long. In effect, these are advancing and retreating longwall systems except packwalls are not used, ad top and bottom rock are not taken in the entries to gain head room made necessary by convergence. In some cases, pillar lines of this kind were developed and operated up to a mile long in southern West Virginia and pillar lines nearly that long have been worked in the north central part of the state. In operating these pillar lines, some under cover as deep as 1800 feet, it was found that:

1. Other things being equal, a long face promotes better roof control.
2. Insofar as roof control is concerned, faces should perhaps be as long as 1 to 1 1/2 times the depth of cover, or longer.
3. Long faces tend to lessen support from solid ribs and thus lower the load on the face. Also, long faces tend to promote less overhang of the roof in goaf areas.
4. Long faces mean more tons per move, and they tend to increase the percentage of recovery.

Individuals in a position to know indicate that the practical length for mechanized retreating longwall faces is under about 900 feet and that such faces work better at 600 or 700 feet. Furthermore, the most economical length may be between 400 and 500 feet.

One thing learned form longwall room and pillar practices in the past was that where complete extraction was impossible, many coals can partially be extracted. Total extraction was prevented because of the difficulty of breaking the strong main roof and because there is a thin friable draw slate or draw rock between the coal and the roof. Examples of just this situation can be found in the Pittsburgh bed in the northern panhandle of West Virginia and in nearby eastern Ohio. There have been few, if any, really successful pillar line operations in this area; however, if enough coal is left to prevent excessive convergence of the roof in face areas and if the workings move rapidly, partial extraction is possible.

Theory of stress discussed

Stresses at the face under two types of roof are depicted in Figure 3.[2] Curve B shows stress conditions when coal is being mined under a heavy, strong sandstone roof and a strong shale floor is present. Such circumstances tend to promote the formation of long, low goaf areas, and to produce high stress areas at and near the retreating face. For example, at mid-bed height stress theoretically runs four to five times greater than that present before the opening was made. The foregoing situation occurs at several mines in southern West Virginia.

Curve E represents the stresses when coal is mined under a comparatively weak roof and over a comparatively weak floor. This leads to formation of narrow high goaf areas with comparatively low stresses at the mine faces, as found in many mines in north central West Virginia.

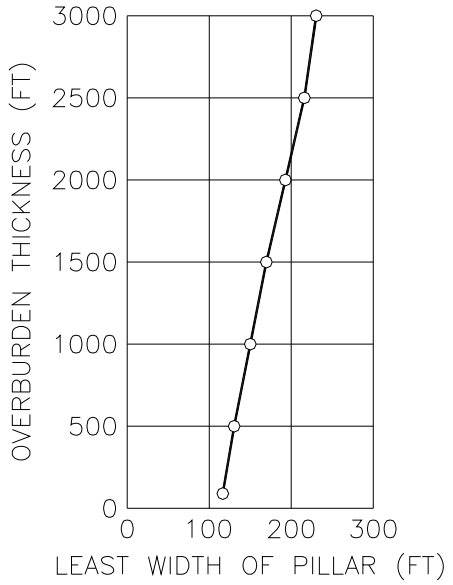


Figure 4. Width of pillar across which stress will not be transmitted at various depths, assuming the coal bed is six feet thick and is composed of coal of medium strength.

The high stress area represented in curve B does not extend far from the mined face. In the most extreme situations, the distance is no more than two, three, or four bed thicknesses; with the more moderate intensities the stresses extend considerably further, but essentially decay to a negligible value. The stress in curve E is more widely distributed along the face but does not reach a high value. In both curves, the stress concentration produced by the opening is confined to areas comparatively close to the face. Consequently, it should not take too wide a pillar to carry this load if protection is to be provided to the tailgate entry form an old goaf in a longwall working.

Shown in Figure 4 is the width of pillar needed at various depths of cover to prevent the transference of stress from an active mining face across the pillar.[3] On a theoretical basis, even under cover 2000 feet deep, the pillar will be somewhat less than 200 feet wide. Under cover 100 feet deep, the pillar should be about 100 feet wide. Since it is not necessary to keep all old goaf stress off of tailgate areas close to the longwall face, goaf pillars could be somewhat less wide than the theoretical values suggested.

A mine pillar with a least lateral dimension greater than 12 times its thickness does not crush out. This has been established in the laboratory in model pillars[4] and observed in mining practice. Therefore, any time a coal pillar is to provide very great strength in mining practice, this can be accomplished by making its least width greater than about 12 or 13 times its thickness.

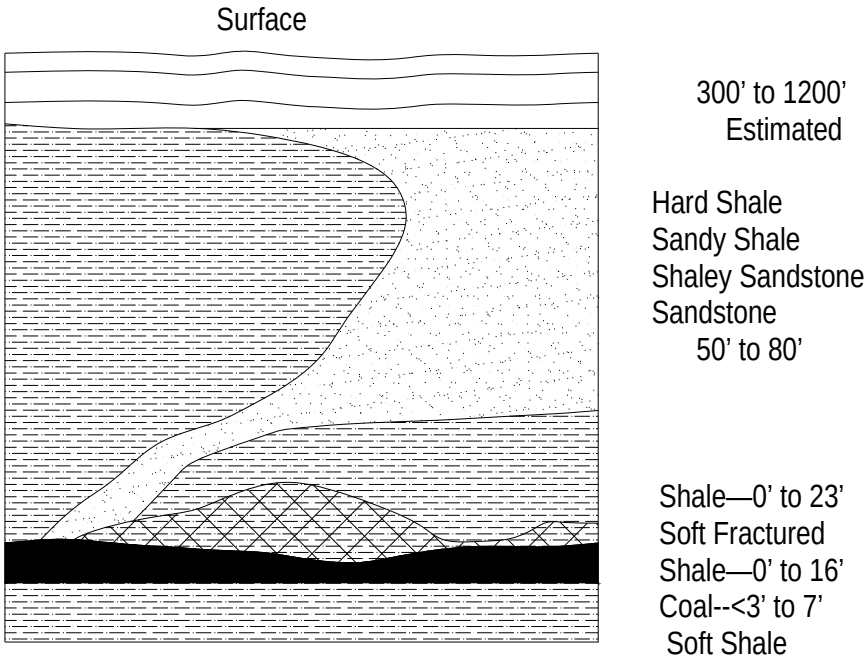


Figure 5

Cross section showing the overburden of one mine which tried a retreating longwall with little success.

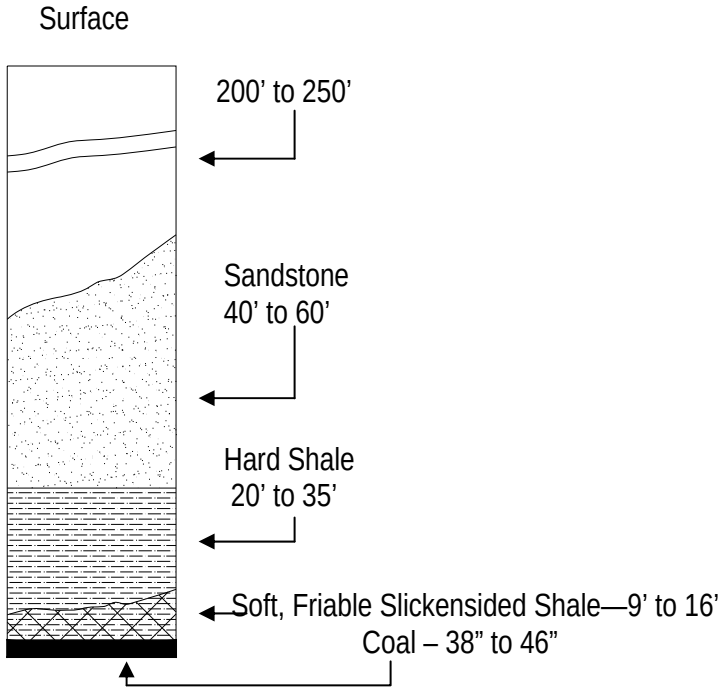


Figure 6

Approximate makeup of the overburden of a mine which has had serious trouble with retreating mechanized longwall.

Fragile roof need not mean failure

Of the mines visited or investigated, a few had not been successful because of working under a fragile roof (Figures 5 and 6). The immediate roof in these unsuccessful operations is a laminated, slickensided, fractured shale that cannot support itself even over narrow works. Above the roof lies a stronger shale and then a heavy strong sandstone or strong sandy shale which can transfer considerable load to the immediate face through the broken shale and can also undergo considerable convergence. As pointed out, in the northern pan-handle of West Virginia, a roof of this nature has always caused trouble in pillar recovery. The roof fails because the deflection of the strong beds immediately above causes it to break at the face and fall out before recovery operations can get underway. Timber is not effective in holding it. By using the pillars left in partial extraction as support (thus keeping deflection at a minimum), and then mining rapidly, this coal can be mined successfully.

If pillars of sufficient size were left to support the main overburden with little deflection (at least for a time after the coal had been removed by longwall), and if sufficient support was provided at the face to limit deflection of the roof to a rather small value, it should be possible to use a retreating longwall under this type of roof without experiencing the problems that beset some of the longwall faces investigated.

To meet the conditions described above, the length of the face must be shortened, so that the main roof span does not fail between the goaf or tailgate pillars on one end of the longwall and the main gate pillars on the other. Also, the pillars should provide for permanent support of the roof without crushing. Finally, it is necessary to leave at least one more pillar in the tailgate to permit adequate ventilation and also to keep floor heave out of the tailgate entry next to the longwall block being mined. Floor heave may be caused by excessive loads on the larger support pillar to be left. This small pillar should be a "yield pillar" (a British term for a pillar not much wider than two or three times its thickness, and capable of yielding without transferring too much load to the bottom). The authors believe that this will confine floor heave, to a considerable extent, to the passageway between the thin pillar and the heavy pillar left for overburden support and leave the tailgate entry next to the longwall block comparatively unaffected.

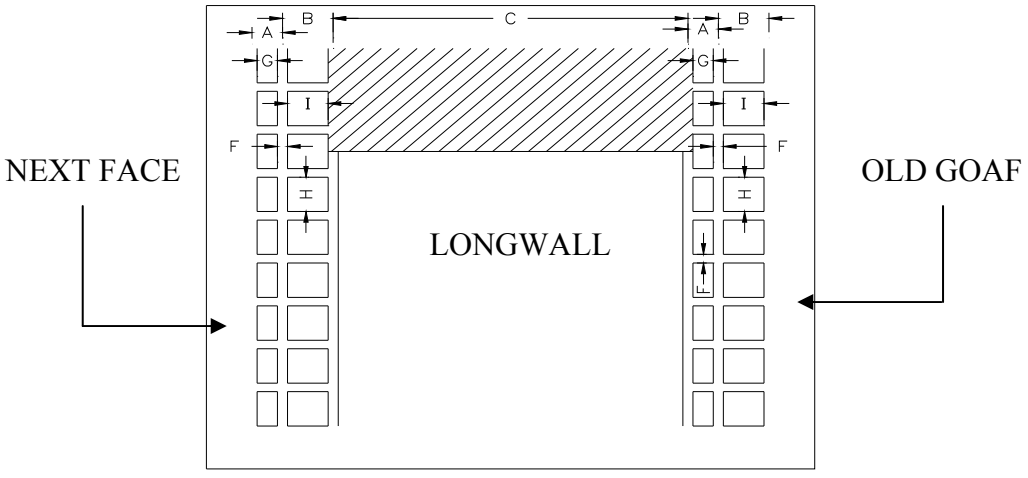


Figure 7

Figure 7 - Schematic layout of a longwall face. Dimensions appear in Tables 1 and 2. Table 1, layout and recovery in retreating mechanized longwall in partial extraction mining. Coal beds consists of 4 1/2 feet of medium strength coal (see Figure 7 for meaning of letters in Table 1).

Authors offer system layouts

Figure 7 and Table 1 describe the elements of longwall mining faces propsed by these authors. As one can note, the face is much shorter than conventional longwalls. Similarly, pillars which are large enough that they will not crush out are being left between the tailgate and the tailgate support pillar. In some situations, experimentation will be necessary to determine the length of face that will prevent the main roof from breaking deflecting, and loading the face. Also on these faces, as much support as possible should be provided by face jacks. Presently, this is about ten tons per square feet of face support.

Estimated recovery on these faces is considerably less than that which is theoretically obtainable or is now being obtained with retaining longwalls (see Table 5). Nevertheless, it is much better than could be expected with room and pillar methods under the conditions we are considering. In the latter case, coal recovery often runs about 40 to 50 percent of the bed, and partial recovery as visualized through longwall methods may greatly improve this figure.

Contrasting with long faces, the set-up expense and capital costs will not be as great on a face of this kind. Moves will be more frequent than with longer faces; but, on the other hand, costs per move will be less, so that the cost-per-ton mined should not be excessive. Everything considered, if this type of operation can be made successful, practically speaking, then mining under this type of roof situation can be a great deal more satisfactory than it has been with room and pillar methods. Also, safety for face personnel will be improved.

TABLE 1

Depth of Cover	Dimension in Feet *							Percent Recovery
	A	B	C	F	G	H	I	
300	45	80	150	20	25	60	60	77
500	45	90	150	20	25	60	70	75
700	45	100	150	20	25	60	80	73
300	45	80	100	20	25	60	60	72
500	45	90	100	20	25	60	70	70
700	45	100	100	20	25	60	80	68

TABLE 2

Cover Thickness	Dimension in Feet Recovery							Percent
	A	B	C	F	G	H	I	
150-400	45	100	600	20	25	80	80	89
150-400	45	100	500	20	25	80	80	86
401-750	45	120	600	20	25	80	100	87
401-750	45	120	500	20	25	80	100	84
751-1100	45	140	600	20	25	80	120	84
751-1100	45	140	500	20	25	80	120	83
1101-2200	45	160	600	20	25	80	140	82
1101-2200	45	160	500	20	25	80	140	81

Table 2 - Panel layout for retreating mechanized longwallusing larger tailgate pillars to improve conditions in the tailgate entries (see Figure 7 for meaning of letters in Table). Coal bed consists of six feet of medium strength coal.

Solution to tailgate problems suggested

In almost every longwall mining installation observed, some degree of roof and floor trouble has been experienced in the tailgates. The trouble consisted of bottom heave or roof falls or bad top generated by excessive weight at the face. This was due to the combined weights transferred to the longwall from the active longwall goaf and from the old goaf (made by the preceding longwall face lying just across the tailgate pillars).

The foregoing has sometimes necessitated using a continuous miner to drive a stall at the tailgate end of the face, which could serve as a tailgate entry. In other cases, men were employed in place of machines to drive the stalls. Nearly always, expensive timbering systems were installed in an effort to take care of this trouble and sometimes they were not too satisfactory.

We know that a pillar can be designed across which stresses from a working face or an old goaf will not be transferred. This principle is used in the design of barrier pillars, and it seems reasonable to think that it could also be used in the design of tailgate pillars in retreating longwall. It is not necessary to prevent transference of all stresses across the tailgate pillars to the longwall face. However, stress transferred to the face should be low enough to prevent excessive bottom heave and serious roof falls and breakage of the top in an area at and near the tailgate end of the longwall face.

Three steps could be taken to alleviate the problem. (1) For protection, leave a pillar which will not crush out next to the old goaf. As indicated previously, such a pillar would need a minimum width of 12 times its thickness, and its length between the old goaf and first tailgate entry, would need to be about 2/3 the length of pillar required to prevent the transference of all stress from the old goaf to the tailgate system. The length of such pillar will be dependent upon the thickness of cover prevailing at the location under consideration (Figure 4). (2) In addition to this support pillar, the tailgate system should consist of two entries separated by a yield pillar. The tailgate entry between the support pillar and the yield pillar will provide relief of bottom heave occasioned by the load on the support pillar. The yield pillar would prevent the transference of excessive load to the floor in the area of the tailgate entry next to the longwall block being mined. (3) Substantial timbering should be installed to provide support along the longwall pillar edge and protection to that half of the width of the tailgate entry next to the longwall block.

The schemes described above for various depths of cover are depicted in Figure 7 and Table 2. In this system, the length of all goaf pillars remains constant at 80 feet (because the bed is six feet thick and

least pillar width should be a minimum of 12 times the thickness), but the width of the goaf support pillar varies from 80 feet to 140 feet as the thickness of the cover increases from 150 to 2200 feet.

A satisfactory recovery can be obtained using a system of this kind although it will not be quite so high as is achieved if the goaf pillar is not made wide enough to afford the protection desired (see Table 5). It is believed that cost of coal lost for this purpose will be offset by better and safer working conditions in the tailgate, and by less equipment and less manpower needed to produce coal from the longwall face. While this design will not take care of all roof troubles that may be encountered in the main or tailgate—such as those due to depositional irregularities in the roof, coal bed and floor—many of them can be handled by conventional timbering methods.

Figure 8

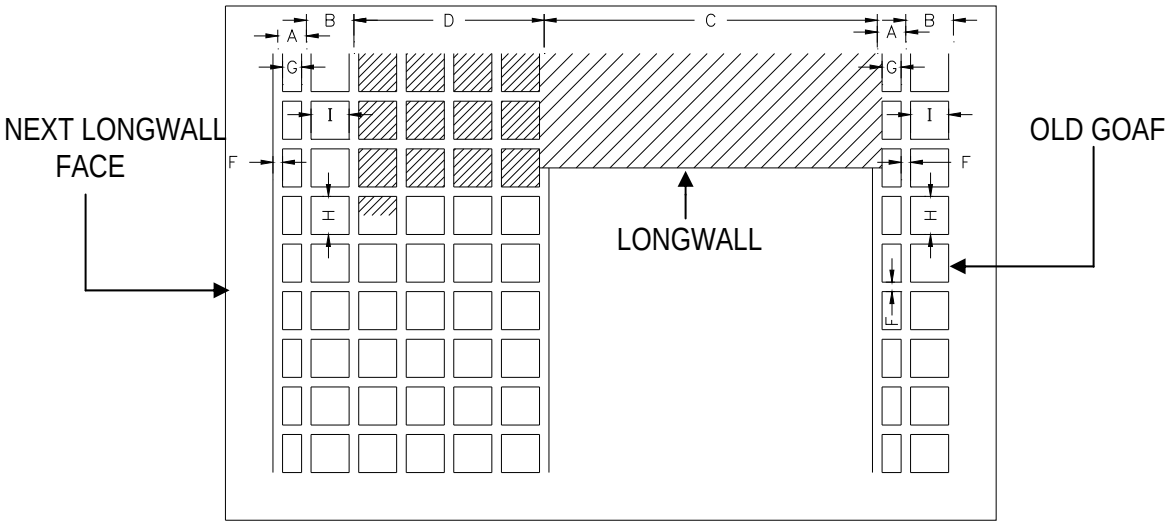


Figure 8 - Layout of a suggested section combining a block system and a retreating longwall. Dimensions are given in Table 3.

TABLE 3

Cover Thickness	Dimension in Feet *								Percent Recovery
	A	B	C	D	F	G	H	I	R
150-400	45	100	600	400	20	25	80	80	88
150-400	45	100	500	400	20	25	80	80	87
401-401	45	120	600	400	20	25	80	100	86
401-401	45	120	500	400	20	25	80	100	85
751-1100	45	140	600	400	20	25	80	120	85
751-1100	45	140	500	400	20	25	80	120	84
1101-2000	45	160	600	400	20	25	80	140	84
1101-2000	45	160	500	400	20	25	80	140	83

Table 3 - Panel layout for retreating longwall combined with a block and conventional mining equipment or with a continuous miner. Coal bed is six feet thick and of medium strength (See Figure 8 for meaning of letters in Table)

Longer faces desirable in retreating installations

For reasons enumerated, it is desirable to use longer faces in retreating longwall installations. A longer face, for example, means lower moving and installation cost per ton of coal mined in addition to better roof control at the face.

One means of accomplishing this consists of a conventional block system, used in conjunction with a retreating longwall (See Figure 8, Table 3). This system affords very good recovery, a larger tonnage per move and a longer face, if properly handled. Protection of the longwall tailgate entries has been provided by wider pillars than those being generally used at the longwall goaf.

The system suggested here should be laid out so that the mining equipment used will provide about the same rate of retreat as the longwall is expected to have. Coordination can be provided by working extra shifts with the longwall or conventional system as required. Ventilation is provided by fresh air coming up the three entries next the longwall block and split at the face. One split goes across the longwall face and out the tailgate entries. The other split ventilates the block pillar line and goes out the tailgate entries provided for the next longwall face. The design depicted is for a working coal bed six feet thick and of medium strength coal.

Figure 9

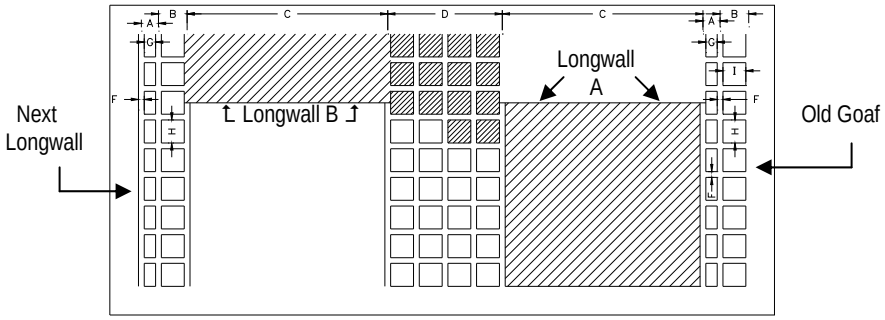


Figure 9 - Layout of a suggested combined longwall and block system of mining. Longwall A is advanced to the end of the section while the block section is being developed slightly ahead of the longwall face. Then the longwall is transferred to B while the blocks previously developed are extracted. The block pillar is kept slightly behind the longwall face on the retreat (See Table 4 for dimensions).

TABLE 4

Cover Thickness	Dimensions in Feet *									Percent Recovery
	A	B	C	D	E	F	G	H	I	
150-400	45	100	600	400	20	25	80	80	80	92
150-400	45	100	500	400	20	25	80	80	80	90.5
401-750	45	120	600	400	20	25	80	80	100	91
401-750	45	120	500	400	20	25	80	80	100	89.7
751-1100	45	140	600	400	20	25	80	80	120	90
751-1100	45	140	500	400	20	25	80	80	120	88.8
1101-2200	45	160	600	400	20	25	80	80	140	89.5
1101-2200	45	160	500	400	20	25	80	80	140	87.9

Table 4 – Panel layout using advancing and retreating mechanized longwall combined with conventional mining equipment and a block system mining layout. Coal bed is six feet thick and of medium strength. (See Figure 9 for meaning of letters).

TABLE 5

Mine Block**	Average Cover	Face Length	Coal Getting Machinery	Recovery Percent	Average Percent Shift	Face OMS	Red Thickness	No. of Entries In gate	Size of Gate Pillar Left**	Size of Entry Development Bloc
	Feet	Feet					Inches		Feet	Feet
A	700	600	Planer	80	595	46	48	3	50 x 80	70 x 100
		600	Planer	80	595	46	48	3	50 x 80	70 x 100
B	1000	600	Planer	88	500	50	56	3	50 x 60	70 x 80
		600	Planer	86	500	50	56	4	80 x 100	100 x 120
C	700	390	Shearer	82	500	48	44	3	70 X 90	50 X 70
D	700	350	Planer	89	500	48	44	2	25 x 80	40 x 100
E	2000	278	Planer	84	724	56	62	4	30 x 80	50 x 100
F	800	550	Shearer	80	850	94	54	4	30 x 80	50 x 100
G	400	400	Shearer	80	400	50	48	3	35 x 80	50 x 100
H	250	400	Shearer	75	500	40	44	4 & 5	40 x 80	60 x 100
I	300	400	Shearer	85	650	65	44	3	45 x 80	60 x 100
J	1800	670	Shearer	92	897	60	56	2	26 x 95	50 x 115

*OMS—OUTPUT PER MAN SHIFT

** IN EVERY CASE THE LONG DIMENSION OF THE ENTRY PILLARS IN TAIL & HEAD GATES PARALLEL THE LONG DIMENSION OF THE LONGWALL BLOCK.

Table 5 - Details of Longwall installations investigated.

Combined longwall and block system proposed

Another method of obtaining a long face and a low move charge is illustrated in Figure 9 and Table 4. In this layout, a four-block panel of conventional mining is being developed simultaneous with the development of the longwall face. The longwall can be worked on the advance and so can the block system (as shown at A, Figure 9). Development of the block system is kept two or three blocks ahead of the longwall system. The belt can be laid either in the center entry or in the entry removed from the longwall goaf by one block. When the longwall face has reached the end of the planned working block (in A), the longwall can be transferred to the other side of the continuous miner section and retreated to the end of the longwall block provided at B in Figure 9. At the same time, the pillars developed in the block system on the advance can be completely extracted by a continuous miner taking care to keep the pillar line slightly behind the longwall face. As the continuous miner is more versatile than the longwall equipment, difficulties encountered in keeping the block system out of the way of longwall operation must be assigned to the work of the block system and the continuous miner.

Ventilation in this system will give no particular trouble because during development fresh air can be carried on the right side of the entry blocks developed in operation A and a split taken over the longwall face and returned down the tailgate. The other split will be taken to the left over the section developing the blocks and returned through the two entries to the left. On the retreat of the longwall, the fresh air would be taken up the left side of the developed blocks with one split being taken across the longwall face and returned through the tailgate entries provided for the longwall operating in B block. The other split would be taken across the pillar line and back down the right side of the system. Arrangements would have to be made at the mouth of the section so that the ventilation could be reversed in the manner required.

Good recovery expected with combined system

If the belt were placed in the middle entry, no particular difficulty would be encountered in getting supplies in on the advance. In retreating, however, it might be necessary to take them in on a shuttle car. In this system, the belt would have to be set up only once for both longwalls and the block system if a cross belt were installed as needed at every third breakthrough.

It is suggested that the tailgate entry pillars be developed in accordance with the principles already set forth, and it will be noted that the blocks referred to in Table 4 adhere to this system for a bed six feet thick composed of medium strength coal. At the finish of the retreating face, the equipment can be transferred to a new longwall panel with a minimum of effort. At no time will it be necessary to move the longwall equipment further than across one face.

Such a system should give very good operating costs as well as high recovery, when compared to present practice (Tables 4 and 5). It should be pointed out that, in the development of the tailgates, some experimentation may be needed to adapt the indicated blocks to whatever conditions are encountered. Sizes suggested should work with little trouble in the entry next to the longwall block. Since (insofar as we know) these systems have not been utilized, success cannot be guranteed; but we believe that development along these lines should pay dividends. Further, we are convinced that the suggestions made concerning tailgate pillars on the goaf side of the tailgate development will limit trouble to a minimum in the tailgate entry next to the block where the tail machinery sits.

Many faces operating under less than favorable conditions

Finally, we sould like to make one more point. We have observed in our studies that some longwall faces have been set up to operate under conditions that were not at all favorable. Certainly they were not as favorable as the organization installing the system could have made them. This involves working a new system with which the mine personnel is completely unfamiliar, and about which neither the management nor supervisory staff knows much more than what they have read or seen. No one making the experiment has had real operating experience in longwall.
The new longwall system is certain to have serious problems of its own even under the best of conditions. Consequently, any organization intending to experiment in the use of retreating mechanized longwall—and the first face to so operate must be considered experimental—should start and operate the face under the very best natural conditions that can be provided. Once operations under the best condition available are mastered, it will be easier to manage the more difficult conditions that might be encountered. This can minimize the grief, trouble, and cost that must come to any organization trying a completely new mining system as complicated as a completely mechanized retreating longwall.

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and
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REFERENCES

[1]LAWALL, C. E., I. A. GIVEN, AND H. G. KENNEDY. "Mining Methods in West Virginia Engineering Experiment Station research Bulletin 4-1929.

[2]HOLLAND, CHARLES T. "Design of Pillars for Overburden Support" Mining Congress Journal, March and April, 1962.

[3]HOLLAND, CHARLES T. "Factors in the Design of Barrier Pillars in Coal Mines", Proceedings of West Virginia Coal Mining Institute, 1965.

[4]HOLLAND, CHARLES T. "The Physical Properties of Coal and Associated Rocks as an Explanation of Bumps in Coal Mines", Trans AIME, Vol. 149, P77, 1942.

[5]HOLLAND, CHARLES T. "Notes on the Theory of the Maximum Pressure Arch and Yield Pillar Techniques as Applied to Entry Panel Design", Proceedings of Coal Mining Institute of America, 1962.

CHAPTER THIRTEEN

OCCUPATIONAL NOISE EXPOSURE

1. Occupational Noise Exposure

SAMPLE QUESTIONS FOR OCCUPATIONAL NOISE EXPOSURE

1. A miner is enrolled in a hearing conservation program when _____.
    a. During any work shift a miner's noise exposure equals or exceeds the action level
    b. The miner requests to be enrolled
    c. It is suspected that the miner's noise exposure has reached the dual hearing protection level
    d. When administrative and engineering controls have failed to reduce the noise exposure to the permissible level

2. Dual hearing protection is required when a miner is exposed to noise levels that exceed a time-weighted average (TWA) of _____.
    a. 105 dBA
    b. 90 dBa
    c. 80 dBa
    d. 85 dBA

3. If during any work shift a miner's noise exposure equals or exceeds the _____ level the mine operator must enroll the miner in a hearing conservation program.
    a. Criterion
    b. Action
    c. Sound
    d. Dual hearing protection level

4. A mine operator must provide a hearing protector to any miner whose noise exposure equals or exceeds the _____ level.
    a. permissible exposure
    b. Action
    c. Sound
    d. Exchange rate

5. The mine operator must provide 30 CFR, Part 62 training to _____.
    a. All miners
    b. Miner's enrolled in a hearing conservation program
    c. New miners as part of the New Miner Safety training program
    d. Only miners older than 40 who have demonstrated a standard threshold shift in hearing.

6. A mine operator must provide hearing protectors and necessary replacements at _____ cost to the miner.
    a. Wholesale
    b. No
    c. Retail
    d. Mine

7. Per 30 CFR, Part 62, dual hearing protection level is _____.
    a. A TWA_8 of 105 dBA, or equivalently, a dose of 800% of that permitted by the standard, integrating all sound levels from 90 dBA to at least 140 dBA
    b. The sound level which if constantly applied for 8 hours results is a dose of 100% of that permitted by the standard (30 CFR 62)
    c. An 8-hour time-weighted average sound level (TWA_8) of 85 dBA, or equivalently a dose of 50% integrating all sound levels from 80 dBA to at least 130 dBA
    d. The amount of increase in sound level, in decibels, which would require halving of the allowable exposure time to maintain the same noise dose.

8. If during any work shift a miner's noise exposure exceeds the permissible exposure level, the mine operator must _____.
    a. Evacuate the miner to the surface
    b. Determine the source of the high noise within 24 hours
    c. Take readings to assure that the dual hearing protection level is not reached
    d. Use all feasible engineering and administrative controls to reduce the miner's noise exposure to the permissible exposure level

9. 30 CFR, Part 62 requires a baseline audiogram for _____.
    a. All miners
    b. Miners who request the testing
    c. Newly hire miners
    d. Miners who are enrolled in a hearing conservation program

10. The purpose of the Occupational Noise Exposure standard, 30CFR, Part 62, is applicable to _____.
    a. Underground mines only
    b. All mines
    c. coal mines only
    d. Only coal mines utilizing longwall production

ANSWER SHEET FOR OCCUPATIONAL NOISE EXPOSURE

1.	a	5.	b
2.	a	7.	a
3.	b	8.	d
4.	b	9.	d
5.	b	10.	b

CHAPTER 14

FUNCTIONAL MATH FOR MINE FOREMAN

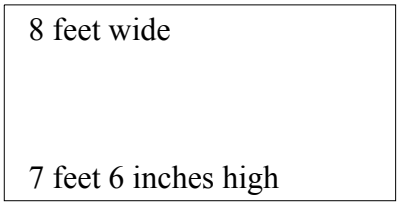
1. Formula Sheet
2. Functional Math

FORMULA SHEET

A formula is like a road map, it helps you find your way from point "a" to point "b". A formula uses letters until a number is found to replace the letter. Here is a example of how a formula works.

What is the area of a regulator that is eight feet wide and seven feet six inches high?

The formula is : Area is Height times Width



a = h x w
a = 7.5 ft x 8 ft
a = 60 ft^2

Note: inches and feet **DO NOT MIX**
The inches were changed to feet by dividing 12 into the inches
6 inches divided by 12 inches is .5 feet
6 4 12 = .5

An example that makes this easy to remember is 12 inches is one foot. This is provided by 12 inches divided by 12 inches is 1 foot.
12 4 12 = 1

Note: The units of measurement is feet. Feet were multiplied by feet, which changed the units to square feet.
Feet times feet is Square feet. Ft x Ft = Ft^2

Letters and What they Represent In Mining Math

a	=	area	c	=	circumference
d	=	diameter	h	=	height
i	=	water gauge in inches	k	=	.00000001
l	=	length	0	=	perimeter
p	=	ventilating pressure	q	=	quantity
r	=	radius	s	=	rubbing surface
v	=	velocity	w	=	width
Π	=	3.1416			

Note: V is usually velocity it can also represent volume.

Information that is critical for the math

1 yard is 3 feet
1 yard^2 is 9 feet^2 { 3 ft x 3 ft = 9 ft^2 }
1 yard^3 is 27 feet^3 { 3 ft x 3 ft x 3 ft = 27 ft^3 }
1 mile is 5280 feet
1 inch of water gauge represents 5.2 pounds per square foot
1 cubic foot will hold 7.5 gallons of water
1 gallon of water weighs about 8.33 pounds
1 cubic foot of solid coal weighs 80 pounds
1 cubic foot of loose coal weighs 50 pounds

Formulas

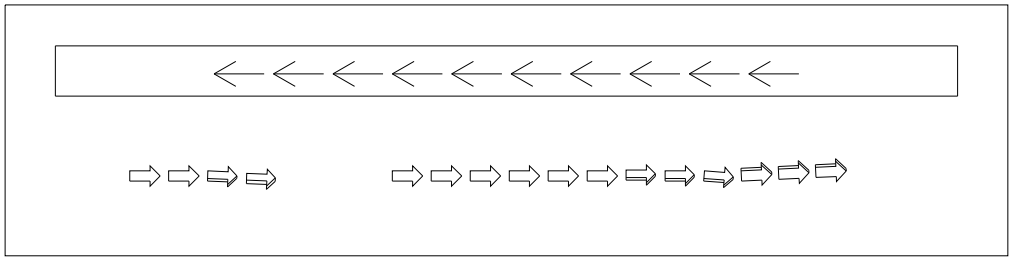
a = h x w ; also area of circle = radius x radius x pi a = r x r Π (You may like Π r^2)
o = h + h + w + w
s = l x o
c = Π x d
p = klov^2 4 a This is sometimes shown this way …p = k s v^2 4 a
liberation = cfm x CH_4 (cfm is cubic feet per minute and CH_4 is methane)
dilution = cfm x CH_4 4 CH_4 ({the first CH_4 is what is present, the second CH_4 is what is wanted} I call the first one the "old" and the second the "new" or what it will be diluted to.)
volume = h x w x l

q = v x a (q is usually recognized as cfm)
v = q 4 a
a = q 4 v or a tee-bar works for these $\frac{cfm}{a|v}$, $\frac{cfm}{?v}$, $\frac{cfm}{a|}$, $\frac{\quad}{a|v}$
h x w x l = cubic feet

Here are the steps for finding how may gallons of water are in a sump, and how long it would take to pump it out.

The volume is the first thing to figure: **h x w x l = cubic feet**
Gallons of water is the next quest: **cubic feet x 7.5 = gallons**
After figuring the gallons the "dreaded pumping" problem can be worked out. Read the problem. There has to be a pump and it is rated in gallons per minute. If there is a volume of water flowing in, this is in gallons per minute also; amount flowing in must be subtracted from the pumping rate.
Pump rate 150 gpm; 100 gpm flowing in; 150 subtract 100 = 50 gpm

Divide the gallons by what the pump is gaining, in this example 50 gpm and the answer is the number of minutes it will take to empty the sump.
Note: q is usually cfm



Mean air velocity (mav) is <u>average</u> air. This measurement is not used a lot and when it is used it generally is applied in mines with low top. A "mean air" reading gives the average air velocity of the air coming in and going out.

Vent tube

Return air

Intake air

Face area

Here is a five step way to figure mean air. It works well for mining applications that use line brattice or ventilation tubing.

Step one figure the area of the face.
Step two figure the area of the vent tubing or the tight side if line brattice is being used.
Step three subtract step two from step one.
Step four figure the cfm.
Cfm is the area where the air reading was taken multiplied by the velocity.
Step five divide the unused or left over area into the cfm.
The areas are used up like this:
Step one is subtracted from
Step two, or the area where the velocity reading was taken is multiplied with
Step three or the unused area is used to divide into the cfm.

1. a = h x w
2. a = h x w or a = r x r x Π
3. a = step one subtract step two
4. cfm = a x v
5. mav = cfm 4 the left over area (loa)

Example for mean air using line brattice:

5 feet high; 18 feet wide Brattice 3 feet from the rib	The velocity reading was taken on the tight side. v = 390 fpm with no correction factor.

1. a = h x w
   a = 5 ft x 18 ft
   a = 90 ft^2

2. a = h x w
   a = 5 ft x 3 ft
   a = 15 ft^2

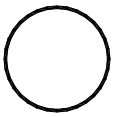
3. a = #1 subtract #2
   a = 90 ft^2 - 15 ft^2
   a = 75 ft^2

4. cfm = a x v
   cfm = 15 ft^2 x 390 fpm
   cfm = 5850

5. mav = cfm 4 the left over area
   mav = 5850 4 75
   mav = 78

Note: The answer is 78. It is a velocity. The full answer is 78 feet per minute. The air moving into the face and the air moving out averages 78 feet per minute.

example for mean air with ventilation tubing:



Entry is 5 ft 6 in high and 19 feet wide; 28 in tube

The velocity reading was taken at the end of the ventilation tubing for 20 seconds it was 454 with no correction factor.
60 seconds 4 20 seconds = 3
454 x 3 = 1362

1. a = h x w
   a = 5.5 ft x 19 ft
   a = 104.5 ft^2

2. a = r x r x Π
   a = 1.1667 ft x 1.1667 ft x 3.1416
   a = 4.2673 ft^2

3. a = #1 subtract #2
   a = 104.5 ft^2 - 4.2673 ft^2
   a = 100.2237 ft^3

4. cfm = a x v
   cfm = 4.2763 ft^2 x 1362 fpm
   cfm = 5824.3206

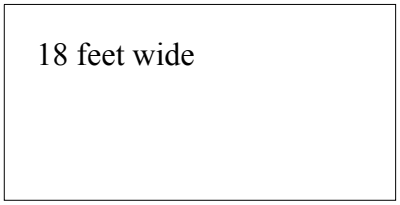
5. mav = cfm 4 the left over area
   mav = 5824.3206 cfm 4 100.2237 ft^2
   mav = 58.1132 fpm

This would round off to **58 fpm.**

example for finding area:

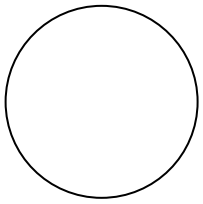
7 feet 9 inches high

Change inches into feet first!
9 inches 4 12 inches = .75 feet



$$a = h \times w$$
$$a = 7.75 \text{ ft} \times 18 \text{ ft}$$
$$a = 139.5 \text{ ft}^2$$

Note: feet times feet equals square feet **ft^2**



This circle has a six foot diameter.

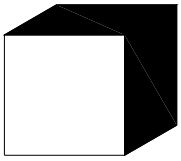
Note: Radius is one half of diameter.
6 ft 4 2 = 3 feet

$$a = r \times r \times \Pi$$
$$a = 3 \text{ ft} \times 3 \text{ ft} \times 3.1416$$
$$a = 28.2744 \text{ ft}^2$$

Yes, this is easy! Understanding how to find the area is a base that helps in working out many of the problems that are part of mining math.

Key:

Write the formula then plug in the numbers as they present themselves. Keep the work neat and orderly so the answers evolve logically without any magic.



example for finding volume:

The block measures seven feet high and eighteen feet wide. It is forty feet deep.

Volume helps answer the question. " How much will it hold"?

$$\mathbf{v = h \times w \times l}$$
$$\mathbf{v = 7 \times 18 \times 40}$$
$$\mathbf{v = 5040 \text{ ft}^3}$$

This would be a basic step in finding an answer to the question; a block of coal measures seven feet high, it is eighteen feet wide and is forty feet deep; how many tons does this weigh?

After the volume has been determined, take the cubic feet and multiply by eighty, **(coal weights 80 pounds per cubic foot on the solid).** This is how many pounds it weighs. Pounds divided by two thousand **(there are 2000 lbs. in a ton)** is the number of tons this block weighs.

5040 x 80 = 403200 pounds

403200 4 2000 = **201.6 tons**

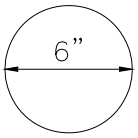
Note:
Coal weighs 80 pounds per cubic foot on the solid.

Coal weighs 50 pounds per cubic foot on the loose, or cut coal.

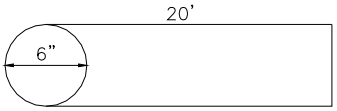
Remember feet times feet times feet equals cubic feet **ft^3**

SAMPLE QUESTIONS ON FUNCTIONAL MATH FOR MINE FOREMAN

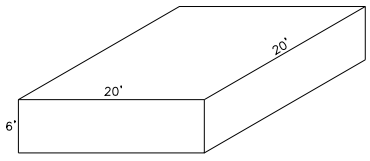
1. Show another way for this term T^4
2. What does this symbol mean? π
3. Find the area for this circle?



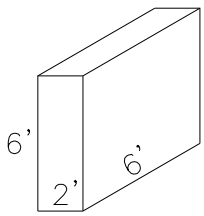
4. Find the volume for this object.



5. A shaft sump is 20’ by 40’ 4” by 60’ 7”. How much water in gallons will it hold?
6. In the diagram below, how many shuttle cars will I get if I have a car factor of 5 ton?



7. Find the volume for this object?



8. A coal truck had a box 6’ by 8’ by 13’. The box was loaded flush to the top. How many tons will it hold?

9. I pour a pad of concrete 7’ 3” by 6’ by 11”. How many yards of concrete did I use?

10. CH_4 is the chemical symbol for _____.

11. What is the numeral notation for 98.78%?

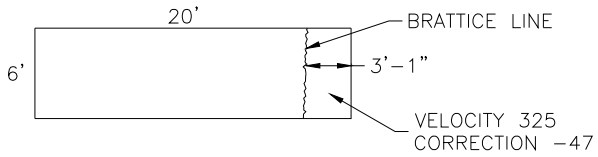
12. What is the numeral notation for 100%?

13. CFM divided by velocity equals _____.

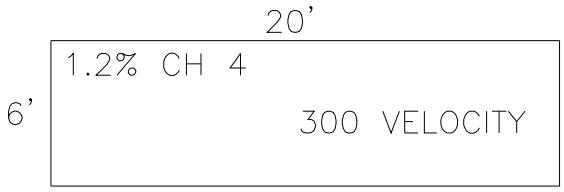
14. (Area) (Velocity + Correction Factor) = _____.

15. (Area) (Velocity + Correction Factor) (CH_4) = _____.

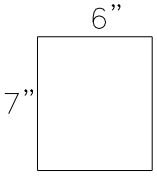
16. In the diagram shown below, what is the mean air velocity?



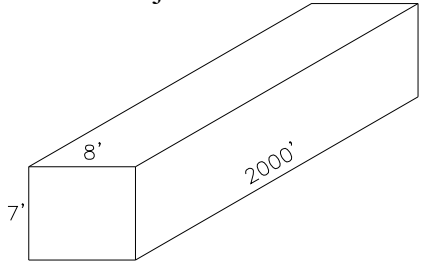
17. In the diagram shown below, what is the cubic feet per day of CH_4?



18. What is the perimeter of this object?



19. What is the rubbing surface of this object?

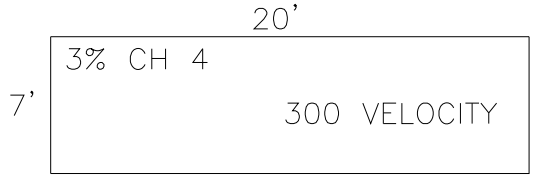


20. Write the formula cubic feet per minute of CH_4.

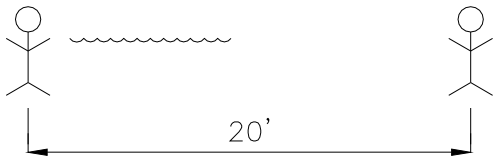
21. The Fireboss takes an air reading in the #4 entry. The reading on the anemometer is 154 feet per minute, with no correction. The area was 4 feet by 20 feet. He also took a CH_4 reading of 1.2%. How much additional air would Brent need to reduce the CH_4 contain to .63%?

22. The main fan return contains 200 cubic feet of CH_4 per minute. How much is being liberated per day?

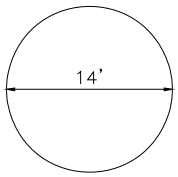
23. In the problem below, find the amount of cfm required to dilute the CH_4 concentration from 3% to .23%.



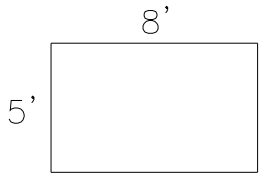
24. Steve F and Dave D decide to take a smoke tube air reading in the #3 entry. Steve measures off 20 feet along the entry. Steve stands at the 20 foot mark and Dave stands at the 0 foot mark as shown in the diagram below. The area of the entry is twenty feet by 6 feet. Steve activates the smoke tube in the direction of Dave. The smoke takes approximately 60 seconds to travel to Dave, how many feet per minute is it traveling?



25. What is the area in this circle?



26. What is the perimeter in this square?



27. If the air velocity in the main return is 125 feet per minute, and the area is 12' by 20'. What is the C.F.M.?

28. A fire boss tells the mine foreman. "I have 58,000 c.f.m. in the main return and the area is 120 square feet". What was the velocity?

29. Where does the anemometer shut off at?
    a. In the middle of the gauge
    b. On the bottom
    c. At the brake
    d. On the side of the fan blades

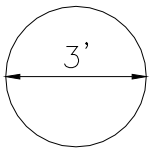
30. In which direction does the air enter the anemometer to turn the gauges in the right direction?
    a. In the front by the gauges
    b. In the back
    c. I do not know!

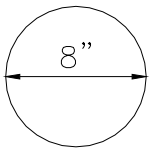
31. A methane mixture is found in the main return of 5%. Put the 5% into decimal point form.

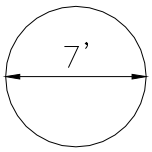
32. A fireboss takes an air reading and comes up with 88,993 C.F.M.. He also takes a methane check and reads a mixture of 1.9%. How much methane is being liberated per minute?

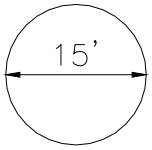
33. A fireboss takes an air reading and comes up with 55,974 C.F.M.. He also takes a methane check and reads a mixture of 7.327%. How much is being liberated per day?

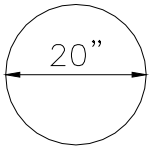
34. Find the area in each circle?

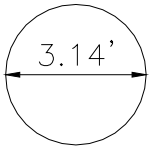
a. 

b. 

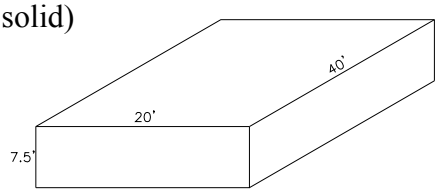
c. 

d. 

e. 

f. 

35. How much coal is in this block?
    (use formula for solid)



36. List the meaning for each letter.
    P = K L O V^2 4 A

37. If the return air current of 40,000 cubic feet per minute contains 6% methane gas, what volume of gas is being removed from the mine each minute?

38. If there is 6,000 cubic feet of air passing per minute through the main return and this current contains 4% CH_4. How much air must be added to the current to reduce it to .74%?

39. If a mine liberates one thousand (1000) cubic feet of methane per minute. How many cubic feet of air will be required per minute to keep the methane content to two tenths (.2%) percent on the return?

40. A three foot fan is exhausting air at a speed of 480 FPM. What is the total quantity of air flow from the fan each minute?

41. How many gallons of water are in a sump 10 feet wide, 20 feet long, and 32 feet deep?

42. How may gallons of water are in a sump 9 feet wide, 15 feet long, and 10 feet deep?

43. A sump is 30 feet wide, 50 feet long, and 4 feet deep and is full of water. If 50 gallons per minute are flowing in . How long will be required to empty the sump with a pump with a capacity of 150 gallons per minute?

44. A sump is 15 feet wide, 45 feet long, and a 3 feet deep and is full of water. If 35 gallons per minutes are flowing in. How long will be required to empty the sump with a pump with a capacity of 36 gallons per minute?

45. How much time would be required to empty a sump 30 feet wide, 50 feet long, if the water is 4 feet deep and the pump capacity is 100 gallons per minute?

46. How many tons of coal can be loaded in a truck which has a box on it which measures 8' wide, 6' high, and 12' long? Assume the truck is flood-loaded exactly level to the top of the box.

47. What is the cross-sectional area of an air course 10' x 15'?

48. What is the perimeter in feet of the above problem?

49. If an entry is 12 feet wide, 9 feet high, and 200 feet long, what is it's volume?

50. What is the area of an airway 5' 6" and 20' 8"?

51. If the velocity is 300 fpm in problem #50, what is the quantity of air flowing in the air course?

52. What is the quantity of air flowing in an airway 17' feet high, 29' wide, if the anemometer reads 175 after 1 minute?

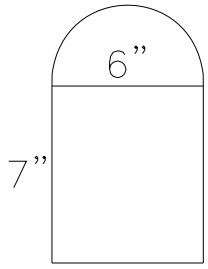
53. What is the cross-sectional area of an airway if the velocity is 250 feet per minute and the quantity is 45000 cfm?

54. What is the velocity of the air flowing in an air course 6’ feet high and 15’ wide, if the quantity is 45,500 cfm?

55. If a regulator is passing 14,500 cubic feet of air per minute at a velocity of 350 per minute, what is the area of the regulator?

56. What is the area of a heading 8’ x 21’?

57. Find the area in this object.



58. If there is 5,000 cubic feet of air passing per minute through the main return and this current contains 5% Ch^4. How much air must be added to the current to reduce it to .74%?

59. If the return air current of 35,800 cubic feet per minute contains 1.5555% methane gas, what volume of gas is being removed from the mine each minute?

60. What is the pressure in this entry?

Length	1 Mile
Height	6 Feet
Width	7 Feet
Velocity	300 FPM

61. How many gallons of water are in a sump 10 feet wide, 15 feet long and 10 feet deep?

62. If an entry contains a quantity of 25,885 cfm, and the velocity is 300 fpm, what is the area?

63. If a smoke travels 37 feet in 7 seconds, how many feet per minute is it traveling?

64. If there is two and one quarter inches of water gauge at the fan, how many pounds per square foot does this represent?

65. Use the answer from problem #65. What is the total pressure against a stopping that measures 18 feet by 6 feet?

66. A fan turns at 100 rpm and delivers 1,000 cfm. What would be the cfm if the fan was turning 150 rpm?

67. What is the area of a circle that has a diameter of 36 inches?

68. If a mine liberates 1.75% methane, and the cfm is 125,000 how much air would be required to cut the methane reading to .5%?

69. What is the rubbing surface of an entry that measures 18 feet by 7 feet by 120 feet?

70. How many tons of coal are in a block 9 feet 3 inches by 19 feet 8 inches by 21 feet 6 inches?

71. A mine liberates 1.2% methane. A velocity reading of 245 with a correction factor of +15 was taken in a place that measured 18 feet 5 inches by 7 feet 6 inches. The rubbing surface is 103,660 square feet. What is the ventilating pressure?

72. What is cross-sectional area of an air course 7' x 8'? What is the perimeter in feet? If the air course is 5,000 feet long, what is the rubbing surface?

73. Determine the volume of air passing per minute through an airway 4 feet 6 inches by 6 feet 9 inches when the anemometer registers 542 rpm.

74. What is the area of an entry 8 feet high and 20 feet wide?

75. What is the perimeter of an entry 8 feet high and 20 feet wide?

76. What is the cross-sectional area of an air course 9 feet high and 18 feet wide?

77. What is the area of a heading 6' x 21'?

78. What is the quantity of an air flowing in an entry 7' 6" high and 20' 3" wide if the velocity is 300 feet per minute?

79. What is the perimeter of an air course 9 feet high and 18' 6" wide?

80. What is the velocity of the air flowing in an air course 10 feet high and 18 feet wide, if the quantity is 45,000 cfm?

81. What is the cross-sectional area of an airway if the velocity is 150 feet per minute and the quantity is 30,000 cfm?

82. If the velocity is 300 fpm and the air course is 6 feet high and 15 feet wide, what is the quantity of air flowing in the air course?

83. If the water gauge reads 2 inches, what is the ventilating pressure?

84. If the ventilating pressure is 15.6 pounds per square foot, what does the water gauge read?

85. How may openings are necessary to provide adequate mine ventilation?

86. If a regulator is passing 15,000 cubic feet of air at a velocity of 300 feet per minute, what is the area of the regulator?

87. If the area is reduced in the proceeding problem to 40 square feet with no change in volume, what is the new velocity?

88. What is the water gauge reading if the pressure is 13.0 pounds per square foot?

89. What is the rubbing surface of an entry 5 feet high, 12 feet wide, and 5,000 feet long?

90. If a return air current of 20,000 cubic feet per minute contains 3 percent marsh gas, what volume of gas is being removed from the mine?

91. If there is 5,000 cubic feet of air passing per minute through the last cut-through in an entry, and this current contains 5% of marsh gas, how much air must be added to the current to reduce it to 1%?

92. With 200,000 cfm of air flow in the main return containing 0.75% methane, how many cubic feet of methane is liberated in the mine each day?

93. Examination of a main return in a gassy mine indicated approximately 1.26% CH_4. You measured the quantity of air to be 100,000 cfm. How much air should be circulated through this mine to decrease the methane content in this return air course to approximately 0.9% CH_4? (Assume the CH_4 generated by the mine remains constant.)

94. In the proceeding problem assume that the speed of the shaft of the axial flow fan is 800 rpm. What should the speed of the fan be increased to in order to provide the required air to dilute the methane to 0.9%? (Assume you intend to increase the air flow by increasing the speed of the fan).

95. If a mine liberates one thousand (1,000) cubic feet of methane per minute, how many cubic feet of air will be required per minute to keep the methane content to five tenths percent (.5%) on the return?

96. A mine fan has a speed of 125 revolutions per minute and delivers 150,000 cubic feet of air. How much air would be delivered with a speed of 200 rpm?

97. What is the area of an entry that measures 18 feet wide and 9 feet high?

98. What is the cross-sectional area of a heading that is 8 feet high and 19 feet wide?

99. What is the area of an object that is round, and measures 7 feet across?

100. How many square feet are in a circle that has a diameter of 12 feet?

101. What is the area of some tubing that has a radius of 2 feet?

102. How many cubic feet are in a silo that has a 48 foot diameter, and is 60 feet high?

103. What is the cfm of a fan that has a velocity of 676 after 20 seconds and has a diameter of 3 feet?

104. How long can 7 people survive behind a barricaded area that has 2 entries that measures 17 feet wide by 7 feet high and are 75 feet long?

105. How much water is in a sump that measures 16 feet wide, 60 feet long, and 6 feet deep?

106. How much water is in the sump in the problem above if it is half full?

107. A mine has an entry that measures 17 feet 9 inches wide and is 6 feet 4 inches high, what is the area of this entry?

108. he mine in problem 132 is 9,000 feet long, what is the rubbing surface?

109. How long can 32 people survive before they would suffer from oxygen depletion if they were barricaded in the mine in problems 132 and 133?

110. What is the ventilating pressure in the mine described in 132 and 133 if the velocity is 400 FPM?

111. What is the ventilating pressure of a mine with a water gauge of 5.5?

112. A return entry measures 18 feet by 9 feet, the velocity was 367 fpm, and the methane was 2%, how much methane is being liberated from this mine each day?

113. What amount of air would be needed to reduce the methane to .5%?

114. Use the information from 137 and 138, how much air was added?

115. A face measures 19 feet across. The brattice is hung on the right side, 3 feet from the rib. A velocity reading was taken behind the brattice, it was 385 with a correction factor of +10. The average height in this area is 5 feet 5 inches. What is the mean air in this entry?

116. What is the mean air in an entry that measures 18 feet wide by 4 feet high? This face is ventilated with exhaust tubing that has 22 inch diameter. A velocity reading at the end of the tubing indicated 725 fpm with a correction of –18.

ANSWER SHEET FOR SAMPLE QUESTIONS ON FUNCTIONAL MATH FOR MINE FOREMAN

1. $T^4 = T \times T \times T \times T$
2. $\pi = 3.1416$
3. $a = \pi r^2$
   $r = \frac{d}{2} = \frac{6"}{2} = 3"$
   $a = \pi \times (3")^2 = 28.274 \text{ in.}^2$

4. $v = a \times l$
   $a = \pi r^2$
   $r = \frac{d}{2} = \frac{6"}{2} = 3"$
   $a = \pi \times (3")^2 = 28.274 \text{ in.}^2 \ 4 \ 144 = 0.196 \text{ ft}^2$
   $v = 0.196 \text{ ft}^2 \times 20' = 3.923 \text{ ft}^3$

5. $v = h \times w \times l$
   $h = 20$ ft.
   $w = 40' + \frac{4"}{12} = 40.333$ ft.
   $l = 60' + \frac{7"}{12} = 60.583$ ft.
   $V = 20 \times 40.333 \times 60.583 = 48{,}869.9 \text{ ft}^3$
   $\text{Gallons} = 48{,}869.9 \text{ ft3} \times \frac{7.5 \text{ gallons}}{\text{ft}^3} = 366{,}524 \text{ gallons}$
6. $V = h \times w \times l$
   $V = 6 \text{ ft.} \times 20 \text{ ft.} \times 20 \text{ ft.}$
   $V = 2{,}400 \text{ ft}^3$
   $\text{Pounds} = 2{,}400 \text{ ft}^3 \times \frac{80 \text{ lbs.}}{\text{ft}^3} = 192{,}000 \text{ pounds}$
   $\text{Tons} = \frac{192{,}000}{2{,}000} = 96 \text{ Tons}$
   $\text{Shuttle Cars} = \frac{96}{5} = 19.2$
7. $V = 6 \text{ ft.} \times 2 \text{ ft.} \times 6 \text{ ft.}$
   $V = 72 \text{ ft}^3$

8. $V = 6 \text{ ft.} \times 8 \text{ ft.} \times 13 \text{ ft.}$
   $V = 624 \text{ ft}^3$
   $\text{Pounds} = 624 \text{ ft}^3 \times \frac{50 \text{ Pounds}}{\text{Ft}^3} = 31{,}200 \text{ pounds}$
   $\text{Tons} = \frac{31{,}200}{2{,}000} = 15.6 \text{ Tons}$

9. $v = h \times w \times l$
   $h = 7\frac{3}{12}$ ft. $= 7.25$ ft.
   $w = 6$ ft.
   $l = \frac{11}{12}$ ft $= 0.917$ ft.
   $V = 7.25 \times 6 \times 0.917 = \frac{39.89 \text{ ft}^3}{27 \text{ ft}^3} = 1.477 \text{ yd}^3$

10. Methane

11. 0.9878

12. 1.00

13. Area

14. CFM

15. Methane Liberation

16. $a = h \times w = 6$ ft. $\times$ 20 ft. $= 120 \text{ ft}^2$ = Entry Area
    $a = 6$ ft. $\times 3\frac{1}{12}$ ft. $= 18.5 \text{ ft}^2$ = Brattice Area
    Mean Area $= 120 - 18.5 = 101.5 \text{ ft}^2$
    CFM $= (18.5 \text{ ft}^2)(325 - 47) = 5{,}143 \text{ ft}^3$ per minute
    Mean Air Velocity $= \frac{5{,}143 \text{ CFM}}{101.5 \text{ ft}^2} = 50.67$ feet per minute

17. Area $= 20$ ft. $\times 6$ ft. $= 120 \text{ ft}^2$
    CFM $= 120 \times 300 = 36{,}000 \text{ ft}^3$ per minute
    Methane Liberation $= 36{,}000 \times 0.012 = 432 \text{ ft}^3$ per minute
    Methane Liberation $= \frac{432 \text{ ft}^3}{\text{min.}} \times \frac{24 \text{ Hrs.}}{\text{day}} \times \frac{60 \text{ min.}}{\text{hr.}} = 622{,}080 \text{ ft}^3$ per day
18. Perimeter $= o = (2 \times 6) + (2 \times 7) = 26$ inches

19. Rubbing Surface $= s = o\,l$
    $o = (2 \times 7) = (2 \times 8) = 30$ feet
    $s = 30$ feet $\times$ 2,000 feet $= 60{,}000 \text{ ft}^2$

20. CH_4 Liberation = CFM $\times$ CH_4

21. Area $= 4 \times 20 = 80 \text{ ft}^2$
    CFM $= 80 \text{ ft}^2 \times 154$ ft./min. $= 12{,}320 \text{ Ft}^3$ per minute
    CH_4 Liberation $= 12{,}320 \times 0.012 = 147.84 \text{ Ft}^3$ per minute
    New CFM $= \frac{147.84}{0.0063} = 23{,}467$ CFM
    Additional CFM $= 23{,}467 - 12{,}320 = 11{,}147$ CFM

22. CH_4 Liberation = $\frac{200\ ft^3}{Min.}$ x $\frac{60\ min.}{Hr.}$ x $\frac{24\ Hrs.}{Day}$ = 288,000 Ft^3 per day

23. CFM = 7 x 20 x 300 = 42,000 Ft^3 per minute
CH_4 CFM = 42,000 x 0.03 = 1,260 Ft^3 per minute
New CFM = $\frac{1{,}260\ ft^3}{0.0023}$ = 547,826 Ft^3 per minute

24. $\frac{20\ ft.}{60\ sec.}$ x $\frac{60\ seconds}{min.}$ = 20 Ft. per minute

25. Area = πr^2
r = $\frac{d}{2}$ = $\frac{14'}{2}$ = 7'
Area = π x 7^2 = 153.94 Ft^2

26. o = (2 x 5) + (2 x 8) = 26 ft.

27. CFM = 125 x 12 x 20 = 30,000 Ft^3 per minute

28. v = $\frac{58{,}000}{120}$ = 483.3 ft^2

29 c

30. b

31. 0.05

32. 88,993 x 0.019 = 1,690.9 ft^3 per minute CH_4

33. 55,974 x 0.07327 = 4,101.2 ft^3 per minute CH_4
$\frac{4{,}101.2\ ft^3}{min.}$ x $\frac{60\ min.}{hr.}$ x $\frac{24\ hrs.}{day}$ = 5,905,749.6 ft^3 per day CH_4

34. a. a = π x $(1.5)^2$ = 7.069 ft^2
b. a = π x 4^2 = 50.266 $in.^2$
c. a = π x $(3.5)^2$ = 38.485 ft^2
d. a = π x $(7.5)^2$ = 176.715 ft^2
e. a = π x 10^2 = 314.159 $in.^2$
f. a = π x $(3.14\ \ 4\ \ 2)^2$ = 7.744 ft^2

35. v = 7.5 x 20 x 40 = 6,000 ft^3
Weight = 6,000 ft^3 x $\frac{80\ lbs.}{ft^3}$ = 480,000 lbs. of coal
Weight = $\frac{480{,}000}{2{,}000}$ = 240 Tons of coal

36. P = Ventilating pressure
K = 0.00000001
L = Length
O = Perimeter
V = Velocity
A = Area

37. 40,000 x 0.06 = 2,400 cfm

38. CH_4 = 6,000 x 0.04 = 240 cfm
New CFM = $\frac{240}{0.0074}$ = 32,432.4 cfm
Additional Air = 32,432.4 - 6,000 = 26,432.4 cfm

39. CH_4 = 1,000 cfm
CFM = $\frac{1,000}{0.002}$ = 500,000 Ft^3 per minute

40. q = π (3 4 2)^2 x 480 = 3,392.9 cfm

41. 10 x 20 x 32 x 7.5 = 48,000 gallons

42. 9 x 15 x 10 x 7.5 = 10,125 gallons

43. Volume = 30 x 50 x 4 x 7.5 = 45,000 gallons
Output = 150 GPM - 50 GPM = 100 GPM
Pumping Time = $\frac{45,000 \text{ Gallons Min.}}{100 \text{ Gallons}}$ = 450 minutes = 7.5 hours

44. Volume = 15 x 45 x 3 x 7.5 = 15,187.5 Gallons
Output = 36 GPM - 35 GPM = 1 GPM
Pumping Time = $\frac{15,187.5 \text{ Gallons}}{1 \text{ Gallon}}$ Min. = 15,187.5 minutes
= 253.125 hours
= 10.55 days

45. Volume = 30 x 50 x 4 x 7.5 = 45,000 Gallons
Pumping Time = $\frac{45,000}{100}$ = 450 minutes = 7.5 hours

46. Volume = 8 x 6 x 12 = 576 ft^3
Coal Weight = 576 ft^3 x $\frac{50 \text{lbs.}}{ft^3}$ = 28,800 lbs.
Coal Weight = $\frac{28,800}{2,000}$ = 14.4 tons

47. Area = 10 x 15 = 150 ft^3

48. Perimeter = (2 x 10) + (2 x 15) = 50 ft.

49. Volume = 12 x 9 x 200 = 21,600 ft^3

50. Area = 5.5 x 20.667 = 113.67 ft^2

51. Q = 113.67 x 300 = 34,101 ft^3 per minute (CFM)

52. Q = 17 x 29 x 175 = 86,275 ft^3 per minute (CFM)

53. $A = \frac{45{,}000}{250} = 180\ ft^2$

54. $V = \frac{45{,}500}{(6 \times 15)} = 505.56$ ft. per minute

55. $A = \frac{14{,}500}{350} = 41.43\ ft^2$

56. A = 8 x 21 = 168 ft^2

57. Rectangle Area = 7 x 6 = 42 $in.^2$
Semicircle Area = $\frac{\pi r^2}{2} = \frac{\pi (6/2)^2}{2} = 14.14\ in.^2$
Total Area = 42 + 14.14 = 56.14 $in.^2$

58. CH_4 = 5,000 x 0.05 = 250 cfm
New Air CFM = $\frac{250}{0.0074} = 33{,}783.8$ cfm
Additional Air = 33,783.8 - 5,000 = 28,783.8 cfm

59. CH_4 = (35,800)(0.0015555) = 55.69 cfm
55.69 ft^3 per minute of CH_4

60. $p = \frac{KLOV^2}{A}$
$p = \frac{(0.00000001)(5{,}280\ ft.)(12 + 14)(300)^2}{6 \times 7}$
p = 2.94 lbs per ft^2

61. V = 10 x 15 x 10 x 7.5 = 11,250 Gallons

62. $A = \frac{25{,}885}{300} = 86.283\ ft^2$

63. $\frac{37\ ft.}{7\ secs.} \times \frac{60\ secs.}{min.} = 317$ ft. per minute

64. $\frac{5.2 \text{ lbs.}}{\text{sq. ft.}} \times 2.25 = 11.7 \text{ lbs. per ft}^2$

65. Area $= 18 \times 6 = 108 \text{ ft}^2$
Total Pressure $= 108 \text{ ft}^2 \times \frac{11.7 \text{ lbs.}}{\text{ft.}^2} = 1{,}263.6 \text{ lbs.}$

66. $\frac{150}{100} \times 1{,}000 = 1{,}500 \text{ cfm}$

67. $A = \pi (36/2)^2 = 324. \text{ in.}^2$

68. $CH_4 = 125{,}000 \times 0.0175 = 2{,}187.5 \text{ cfm}$
New Air Quantity $= \frac{2{,}187.5}{0.005} = 437{,}500 \text{ cfm}$

69. $ol = [(2 \times 18) + (2 \times 7)] \times 120 = 6{,}000 \text{ ft}^2$

70. Weight $= 9.25 \times 19.67 \times 21.5 \times 80 = 312{,}949.7 \text{ lbs.}$
Weight $= \frac{312{,}949.7 \text{ lbs.}}{2{,}000} = 156.5 \text{ Tons}$

71. $p = \frac{(0.00000001)(103{,}660)(260)^2}{(18.417 \times 7.5)} = 0.507 \text{ lbs. per ft}^2$

72. Area $= 7 \times 8 = 56 \text{ ft}^2$
Perimeter $= (2 \times 7) + (2 \times 8) = 30 \text{ ft}^2$
Rubbing Surface $= 30 \times 5{,}000 = 150{,}000 \text{ ft}^2$

73. $Q = 4.5 \times 6.75 \times 542 = 16{,}463 \text{ cfm}$

74. Area $= 8 \times 20 = 160 \text{ ft}^2$

75. Perimeter $= (2 \times 8) + (2 \times 20) = 56 \text{ ft.}$

76. Area $= 9 \times 18 = 162 \text{ ft}^2$

77. Area $= 6 \times 21 = 126 \text{ ft}^2$

78. $Q = 7.5 \times 20.25 \times 300 = 45{,}562.5 \text{ cfm}$

79. Perimeter $= 2 (9 + 18.5) = 55 \text{ ft.}$

80. $V = \frac{45{,}000}{(10 \times 18)} = 250 \text{ ft. per minute}$

81. $A = \frac{30{,}000}{150} = 200 \text{ ft}^2$

82. $Q = 300 \times 6 \times 15 = 27{,}000$ cfm

83. $P = 2 \times \frac{5.2 \text{ lbs.}}{\text{ft}^2} = 10.4$ lbs per ft^2

84. $\frac{15.6}{5.2} = 3$ in. W.G.

85. A minimum of two: intake and return

86. $A = \frac{15{,}000}{300} = 50 \text{ ft}^2$

87. $V = \frac{15{,}000}{40} = 375$ ft. per minute

88. $\frac{13}{5.2} = 2.5$ in. W.G.

89. $s = [2(5 + 12)] \times 5{,}000 = 170{,}000 \text{ ft}^2$

90. Gas Quantity $= 20{,}000 \times 0.03 = 600$ cfm

91. Gas Quantity $= 5{,}000 \times 0.05 = 250$ cfm
New Air Quantity $= \frac{250}{0.01} = 25{,}000$ cfm
Additional Air Quantity $= 25{,}000 - 5{,}000 = 20{,}000$ cfm

92. CH_4 Quantity $= 200{,}000 \times 0.0075 = 1{,}500$ cfm
CH_4 Quantity $= \frac{1{,}500 \text{ ft}^3}{\text{min.}} \times \frac{60 \text{ min.}}{\text{hr.}} \times \frac{24 \text{ hrs.}}{\text{day}} = 2{,}160{,}000 \text{ ft}^3$ per day

93. CH_4 Quantity $= 100{,}000 \times 0.0126 = 1{,}260$ cfm
New Air Quantity $= \frac{1{,}260 \text{ CFM}}{0.009} = 140{,}000$ cfm

94. $\frac{140{,}000}{100{,}000} \times 800 = 1{,}120$ RPM

95. Air Quantity $= \frac{1{,}000}{0.005} = 200{,}000$ cfm

96. $\frac{200}{125} \times 150{,}000 = 240{,}000$ cfm

97. $A = 18 \times 9 = 162 \text{ ft}^2$

98. $A = 8 \times 19 = 152 \text{ ft}^2$

99. $A = \pi (7/2)^2 = 38.49 \text{ ft}^2$

100. $A = \pi (12/2)^2 = 113.097 \text{ ft}^2$

101. $A = \pi 2^2 = 12.566 \text{ ft}^2$

102. $V = \pi (48/2)^2 \times 60 = 108{,}573 \text{ ft}^3$

103. $Q = (676 \times 3) \times \pi (3/2)^2 = 14{,}335 \text{ cfm}$

104. $\text{Volume} = (17 \times 7 \times 75) \times 2 = \frac{17{,}850 \text{ ft}^3}{27} = 661.1 \text{ Yd}^3$

105. $V = 16 \times 60 \times 6 \times 7.5 = 43{,}200 \text{ Gallons}$

106. $\frac{43{,}200}{2} = 21{,}600 \text{ Gallons}$

107. $A = 17.75 \times 6.33 = 112.41 \text{ ft}^2$

108. $S = [2(17.75 + 6.33)] \times 9{,}000 = 433{,}494 \text{ ft}^2$

109. $V = 17.75 \times 6.33 \times 9{,}000 = \frac{1{,}011{,}217.5 \text{ ft}^3}{27} = 37{,}452.5 \text{ Yd}^3$

$\text{Respiration Time} = \frac{37{,}452.5 \text{ Yd}^3 \text{ hr.}}{\text{Yd}^3 \ 32} = 1{,}170.4 \text{ hrs.} = 48.8 \text{ days}$

110. $p = \frac{(0.00000001)(433{,}494)(400)^2}{(17.75 \times 6.33)} = 6.17 \text{ lbs. per ft}^2$

111. $p = 5.5 \times \frac{5.2 \text{ lbs.}}{\text{ft}^2} = 28.6 \text{ lbs. per ft}^2$

112. $CH_4 \text{ Quantity} = 18 \times 9 \times 367 \times 0.02 = 1{,}189.1 \text{ cfm}$

$\frac{1{,}189.1 \text{ ft}^3}{\text{min.}} \times \frac{60 \text{ min.}}{\text{hr.}} \times \frac{24 \text{ hrs.}}{\text{day}} = 1{,}712{,}275 \text{ ft}^3/\text{day}$

113. $\text{Air Quantity} = \frac{1{,}189.1}{0.005} = 237{,}820 \text{ cfm}$

114. $\text{Additional Air Quantity} = 237{,}820 - 59{,}454 = 178{,}366 \text{ cfm}$

115. $a = 19 \times 5.417 = 102.92 \text{ ft}^2 = \text{Entry Area}$

$a = 3 \times 5.417 = 16.25 \text{ ft}^2 = \text{Brattice Area}$

$\text{Mean Area} = 102.92 - 16.25 = 86.67 \text{ ft}^2$

$\text{Quantity} = (16.25)(385 + 10) = 6{,}418.75 \text{ cfm}$

$\text{Mean Velocity} = \frac{6{,}418.75}{86.67} = 74.06 \text{ ft. per minute}$

116. $a = 18 \times 4 = 72\ ft^2$ = Entry Area

$a = \pi [22/(12 \times 2)]^2 = 2.64\ ft^2$ = Tubing Area

Mean Area = $72 - 2.64 = 69.36\ ft^2$

Quantity = $(2.64)(725 - 18) = 1{,}866.5$ cfm

Mean Velocity = $\frac{1{,}866.5}{69.36}$ = 26.9 ft per minute